# the 1964 TEMPEST

## CHASSIS SHOP MANUAL

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# 1964 PONTIAC TEMPEST

# CHASSIS SHOP MANUAL

## TABLE OF CONTENTS



### GENERAL

This shop manual applies to 1964 Pontiac Tempest models. It contains information on all components of the car with the exception of the air conditioning system and body which are covered in separate manuals. New Vehicle Warranty and other information pertaining to Pontiac Tempest models is contained in the Owner Protection Plan booklet which accompanies each vehicle.

### CONTENTS

Arrangement of the material is shown by the table of contents on the right-hand side of this page. Black tabs on the first page of each section can be seen on the edge of the book below the section title. A more detailed table of contents precedes each section, and an index is included in the back of the manual.

### *AIR CONDITIONING CAUTION*

*It is extremely important that proper methods and precautions be observed when disconnecting any refrigerant lines or units. Check information published concerning air conditioning prior to performing operations of this nature. Failure to observe this caution may result in injury to personnel or cause extensive damage to the air conditioning system.*

PONTIAC MOTOR DIVISION
GENERAL MOTORS CORPORATION
PONTIAC 11, MICHIGAN

GM Restoration Parts

S-6404 T    August 1963    Litho in U.S.A.

# GENERAL INFORMATION

## CONTENTS OF THIS SECTION



## GENERAL INFORMATION

General information and general specifications appear in this section. Detailed specifications are given on major units at the end of each section of this manual.

### *VEHICLE IDENTIFICATION PLATE*

Serial, assembly plant and model year identification can be made from the Manufacturer's Motor Vehicle Identification Number Plate. This plate is a metal strip which is fastened to the left front hinge pillar post, visible when the left front door is open. The plate has embossed numerals as shown in Fig. 1-1.

### *BODY IDENTIFICATION PLATE*

Identification as to body style, body number, trim and paint is carried on a plate (Fig. 1-2) attached to the left side of the cowl just under the rear edge of the hood.

### *CAR MODEL IDENTIFICATION*

Certain publications carry "series" numbers to identify models and others carry sales department names. Figure 1-3 below shows both methods of identification.

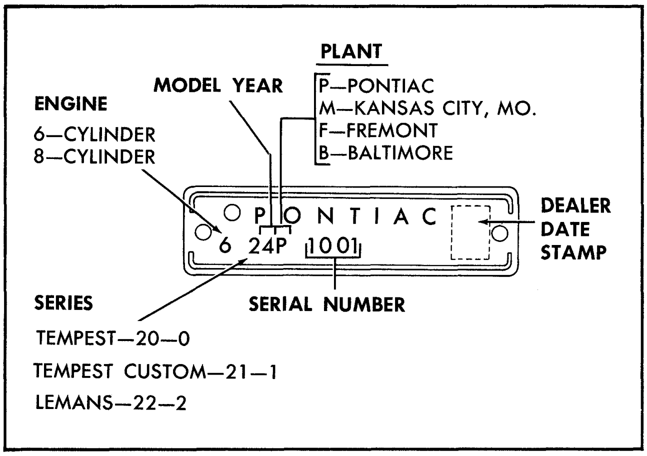



Fig. 1-1 Vehicle Identification Number Plate

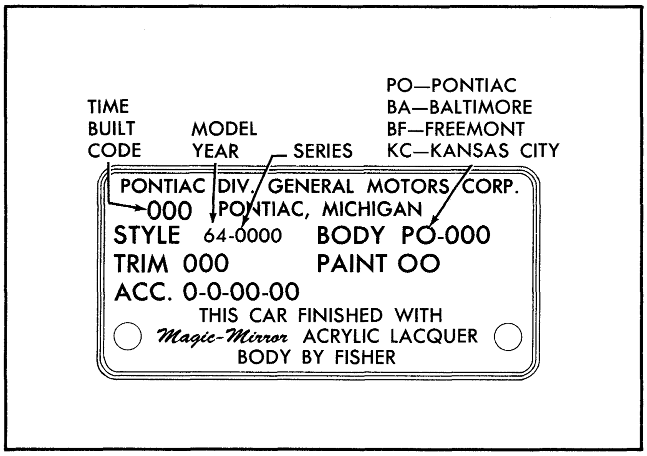



Fig. 1-2 Body Identification Plate

| Series | Model | Style Number |
|---|---|---|
| 2000 | Tempest Sports Coupe | 2027 |
| | Tempest 4-Door Sedan | 2069 |
| | Tempest Safari | 2035 |
| 2100 | Tempest Custom Sports Coupe | 2127 |
| | Tempest Custom 4-Door Sedan | 2169 |
| | Tempest Custom Convertible | 2167 |
| | Tempest Custom Safari | 2135 |
| 2200 | Le Mans Sports Coupe | 2227 |
| | Le Mans Convertible | 2267 |

Fig. 1-3 Car Model Identification

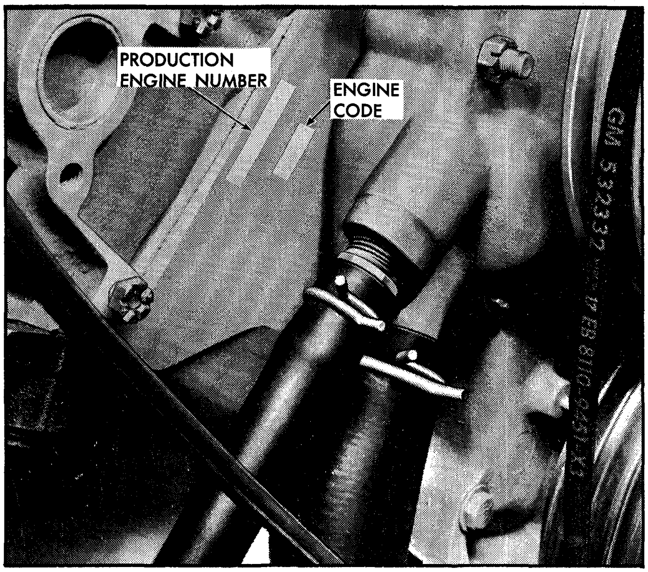



Fig. 1-4 Engine Serial Number Location

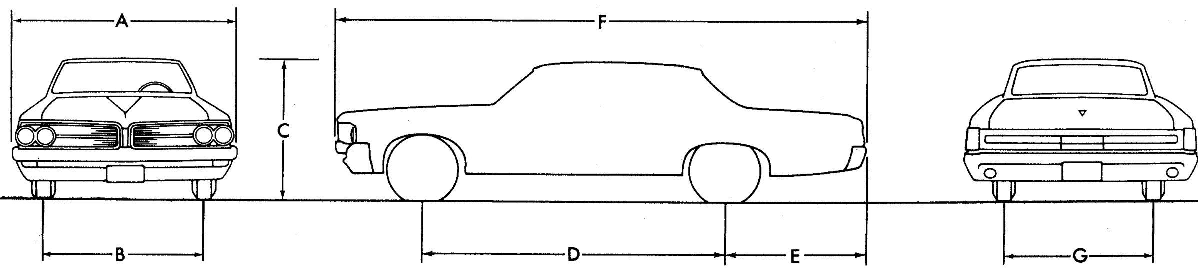
## ENGINE SERIAL NUMBERS

The engine production number and engine code are located on the front of the right-hand bank of the block (Fig. 1-4).

### *CODING SIDE BAR LOCK*

The side bar lock is used on the ignition, front door and rear deck lid lock. Uncoded side bar locks may be coded to match the keys used on the car. Locks are received without tumblers, springs or retainers which are available separately. Four different tumblers are available, only approved parts should be used.

## GENERAL SPECIFICATIONS




| DIMENSION | KEY | Two Door Coupes 2027, 2127, 2227 | Four Door Sedans 2069, 2169 | Convertibles 2167, 2267 | Four Door Station Wagon 2035, 2135 |
|---|---|---|---|---|---|
| Over-All Length | F | | 203" | | |
| Width | A | | 73.3" | | |
| Height (Unloaded) | C | 53.6" | 54.0" | 54.2" | 55.3" |
| Wheelbase | D | | 115" | | |
| Tread Front | B | | 58" | | |
| Tread Rear | G | | 58" | | |
| Road Clearance | - | 6.05" | 6.30" | 6.05" | 7.55" |
| Overhang Front | - | | 33.2" | | |
| Overhang Rear | E | | 54.5" | | |
| Tire Size | - | | 6.50 x 14 | | 7.00 x 14 |
| 6 Cylinder w/o A.C. | | | | | |
| Tire Size 8 Cylinder and A.C. | - | | 7.00 x 14 | | |

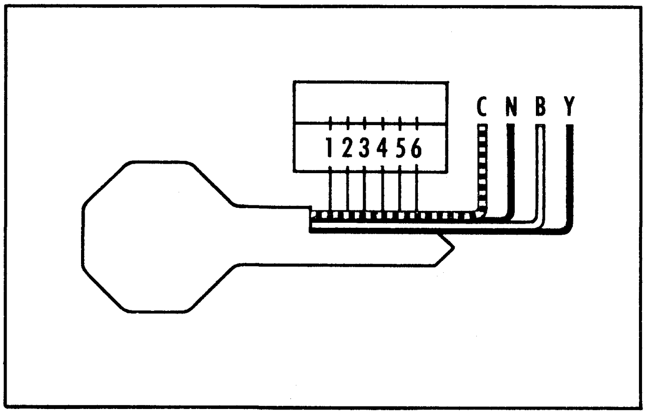



Fig. 1-5 Key Coding Diagram

Before the lock may be coded the code of the key must be determined. If the numbered blank surrounding the hole in the key head has not been removed the code may be determined by consulting lock manufacturers code book. Should the blank be missing from the key the coding sequence may be readily determined as follows:

1. Place key on diagram (Fig. 1-5) with bottom, head and point aligned.

2. Starting at the head of the key, code each of six cuts either C-N-B or Y by recording which area the bottom of the cut leaves exposed. Example: If the first line from the top is the only line exposed the cut would be coded C.

After the key code has been determined the correct tumblers should be installed as follows:

1. The letters determined from coding the key indicate different colored tumblers to be installed in slots of the lock (Fig. 1-6).

2. Beginning with slot next to head (number one position) install tumbler of color coinciding with letter determined from key code. Install correct tumblers in remaining five slots.

| LETTER | COLOR | DEPTH SET AT |
|---|---|---|
| C | Copper | .000 |
| N | Nickel | .025 |
| B | Black | .050 |
| Y | Yellow | .075 |

Fig. 1-6 Tumbler Color Chart

3. Insert spring in each round cavity in each tumbler lock between slots.

*NOTE: Do not pull springs apart, twist them apart.*

4. Install spring retainer over springs with ends inserted in slots.

5. Side bar will now drop in place when key is inserted if correct tumblers have been installed.

6. Stake spring retainer in place using screwdriver and light hammer.

### LIFTING AND TOWING

LIFTING

The Tempest may be lifted at any accessible point on the frame rail. It can also be lifted at the front cross member or at either the front or rear lower control arms. When lifting on the lower control arms, use care to avoid the lower shock absorber brackets.

Under no circumstances should lift adapters be used on the bumpers, propellor shaft, axle shafts, transmission, rear axle or engine.

The propellor shaft and the exhaust system are lower than the side rails. Lift adapters must provide adequate clearance height for these parts.

### TOWING PRECAUTIONS

Always place a rubber mat or other suitable material between the bumper and the tow chains or cables. For front end lifting, place the chains or cables around the ends of the frame side rails at both sides. All models can be towed without disconnecting the propeller shaft except in cases where the transmission or propeller shaft has possibly been subject to failure or damage. In such cases, the propeller shaft must be disconnected from the differential and wired to the tail pipe or the car must be towed with the rear wheels off the ground. If the propeller shaft is disconnected and the "U" joint bearing retaining strap is broken, wrap tape around the bearing caps to prevent loss. When towing with the rear wheels off the ground, the steering wheel must be centered and held in position by a steering wheel holding clamp or by tying it to the window division channel. Tire to ground clearance should not exceed 6 inches while towing the car and speeds should not exceed 30 MPH.

*CAUTION: Power steering equipped cars should be towed with caution, since there is no power assist with the engine off.*

## SPEEDOMETER GEAR USAGE

| REAR AXLE RATIO | TIRE SIZE 6.50 x 14 | 7.00 x 14 | 7.50 x 14 | NO. DRIVE GEAR TEETH | NO. DRIVEN GEAR TEETH | DRIVEN GEAR COLOR | ADAPTER RATIO | ADAPTER COLOR |
|---|---|---|---|---|---|---|---|---|
| AUTOMATIC TRANSMISSION | | | | | | | | |
| 41:11 (3.73) | X | X | | 18 | 45 | Lt. Blue | .8653 | Blue |
| | | | X | 18 | 43 | Purple | .8653 | Blue |
| 39:11 (3.55) | X | X | | 18 | 43 | Purple | .8653 | Blue |
| | | | X | 18 | 41 | Yellow | .8653 | Blue |
| 37:11 (3.36) | X | X | | 18 | 41 | Yellow | .8653 | Boue |
| | | | X | 18 | 39 | Brown | .8653 | Blue |
| 42:13 (3.23) | X | X | | 18 | 45 | Lt. Blue | - | - |
| | | | X | 18 | 43 | Purple | - | - |
| 40:13 (3.08) | X | X | | 18 | 43 | Purple | - | - |
| | | | X | 18 | 41 | Yellow | - | - |
| 51:14 (2.93) | X | X | | 18 | 41 | Yellow | - | - |
| | | | X | 18 | 39 | Brown | - | - |
| 39:14 (2.78) | X | X | | 18 | 39 | Brown | - | - |
| | | | X | 18 | 37 | Red | - | - |
| 41:16 (2.56) | X | X | | 18 | 36 | White | - | - |
| | | | X | 18 | 34 | Lt. Green | - | - |
| 3-SPEED SYNCHROMESH TRANSMISSION | | | | | | | | |
| 43:10 (4.30) | X | | | 8 | 21 | Red | .7692 | Yellow |
| | | X | X | 8 | 20 | Blue | .7692 | Yellow |
| 41:11 (3.73) | X | X | | 8 | 20 | Blue | .8653 | Blue |
| | | | X | 8 | 19 | Natural | .8653 | Blue |
| 39:11 (3.55) | X | X | | 8 | 19 | Natural | .8653 | Blue |
| | | | X | 8 | 18 | Brown | .8653 | Blue |
| 39:10 (3.90) | X | X | | 8 | 21 | Red | .8653 | Blue |
| | | | X | 8 | 20 | Blue | .8653 | Blue |
| 42:13 (3.23) | X | X | | 8 | 20 | Blue | - | - |
| | | | X | 8 | 19 | Natural | - | - |
| 40:13 (3.08) | X | X | | 8 | 19 | Natural | - | - |
| | | | X | 8 | 18 | Brown | - | - |
| 37:11 (3.36) | X | X | | 8 | 21 | Red | - | - |
| | | | X | 8 | 20 | Blue | - | - |
| 4-SPEED SYNCHROMESH TRANSMISSION | | | | | | | | |
| 43:10 (4.30) | | X | | 6 | 20 | Yellow | - | - |
| | X | | | 6 | 20 | Yellow | - | - |
| | | | X | 6 | 19 | Orange | - | - |
| 41:11 (3.73) | X | | | 6 | 18 | Green | - | - |
| | | X | X | 6 | 17 | Black | - | - |
| 39:11 (3.55) | | X | X | 8 | 21 | Red | - | - |
| 39:10 (3.90) | X | X | | 6 | 18 | Green | - | - |
| | | | X | 6 | 17 | Black | - | - |
| 42:13 (3.23) | X | X | | 8 | 20 | Blue | - | - |
| | | | X | 8 | 19 | Natural | - | - |
| 40:13 (3.08) | X | X | | 8 | 19 | Natural | - | - |
| | | | X | 8 | 18 | Brown | - | - |
| 37:11 (3.36) | X | X | | 8 | 21 | Red | - | - |
| | | | X | 8 | 20 | Blue | - | - |

# MISCELLANEOUS INFORMATION

## DECIMAL EQUIVALENTS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1/64 | .015625 | 17/64 | .265625 | 33/64 | .515625 | 49/64 | .765625 |
| 1/32 | .03125 | 9/32 | .28125 | 17/32 | .53125 | 25/32 | .78125 |
| 3/64 | .046875 | 19/64 | .296875 | 35/64 | .546875 | 51/64 | .796875 |
| 1/16 | .0625 | 5/16 | .3125 | 9/16 | .5625 | 13/16 | .8125 |
| 5/64 | .078125 | 21/64 | .328125 | 37/64 | .578125 | 53/64 | .828125 |
| 3/32 | .09375 | 11/32 | .34375 | 19/32 | .59375 | 27/32 | .84375 |
| 7/64 | .109375 | 23/64 | .359375 | 39/64 | .609375 | 55/64 | .859375 |
| 1/8 | .125 | 3/8 | .375 | 5/8 | .625 | 7/8 | .875 |
| 9/64 | .140625 | 25/64 | .390625 | 41/64 | .640625 | 57/64 | .890625 |
| 5/32 | .15625 | 23/32 | .40625 | 21/32 | .65625 | 29/32 | .90625 |
| 11/64 | .171875 | 27/64 | .421875 | 43/64 | .671875 | 59/64 | .921875 |
| 3/16 | .1875 | 7/16 | .4375 | 11/16 | .6875 | 15/16 | .9375 |
| 13/64 | .203125 | 29/64 | .453125 | 45/64 | .703125 | 61/64 | .953125 |
| 7/32 | .21875 | 15/32 | .46875 | 23/32 | .71875 | 31/32 | .96875 |
| 15/64 | .234375 | 31/64 | .484375 | 47/64 | .734375 | 63/64 | .984375 |
| 1/4 | .25 | 1/2 | .5 | 3/4 | .75 | 1 | 1. |

## WEIGHTS AND MEASURES

### LINEAR MEASURE

1/12 foot (ft.) . . . . . . . . . . . . . . =1 inch (in.)
12 inches . . . . . . . . . . . . . . . . . . . =1 foot
3 feet . . . . . . . . . . . . . . . . =1 yard (1 yd.)

### AREA MEASURE

1/144 square foot (sq. ft.) . . =1 square inch (sq. in.)
144 square inches . . . . . . . . . =1 square foot
9 square feet . . . . . . =1 square yard (sq. yd.)

### LIQUID MEASURE

1/16 pint (pt.) . . . . . . . . . . . . . =1 ounce (oz.)
1 pint. . . . . . . . . . . . . . . . . . . . =16 ounces
2 pints . . . . . . . . . . . =1 quart (qt.) 32 ounces
4 quarts . . . . . . . . . . . . . . =1 gallon (gal.)
31 1/2 gallons . . . . . . . . . . . =1 barrel (bbl.)

### DRY MEASURE

1/2 quart (qt.) . . . . . . . . . . . . . =1 pint (pt.)
2 pints . . . . . . . . . . . . . . . . =1 quart (qt.)
8 quarts . . . . . . . . . . . . . . . =1 peck (pk.)
4 pecks . . . . . . . . . . . . . . =1 bushel (bu.)
105 quarts . . . . . . . . . . . . . . . . =1 barrel

### CUBIC MEASURE

1,728 cubic inches . . . . . . . . . . =1 cubic foot
27 cubic feet . . . . . . . . . . . . =1 cubic yard

### COMMON WEIGHT

16 ounces . . . . . . . . . . . . . . . . . =1 pound
100 pounds . . . . . . . =1 hundred weight (cwt.)
2000 pounds . . . . . . . . . . . . . . . . . . =1 ton

### COMMON U.S.A. EQUIVALENTS
### LENGTH

1 inch . . . . . . . . . . . . =25.4001 millimeters
1 millimeter. . . . . . . . . . . . =0.03937 inches
1 foot . . . . . . . . . . . . . . =0.304801 meters
1 meter . . . . . . . . . . . . . . . =3.28083 feet
1 yard . . . . . . . . . . . . . . =9.914402 meters
1 meter . . . . . . . . . . . . . . =1.093611 yards
1 mile . . . . . . . . . . . . =1.609347 kilometers
1 kilometer . . . . . . . . . . . . =0.621370 miles

### DRY CAPACITY

1 quart. . . . . . . . . . . . . . . . . =0.94633 liters
1 liter . . . . . . . . . . . . . . . . =1.05671 quarts
1 gallon . . . . . . . . . . . . . . . =3.78533 liters
1 liter . . . . . . . . . . . . . . . =0.26418 gallons

### LIQUID CAPACITY

1 quart. . . . . . . . . . . . . . . . . . =1.1012 liters
1 liter . . . . . . . . . . . . . . . . . =0.9081 quarts
1 peck . . . . . . . . . . . . . . . . . . =3.310 liters
1 liter . . . . . . . . . . . . . . . . . =0.11351 pecks

## DRILL SIZES

| Letter Sizes | Drill Diam. Inches | Wire Gage Sizes | Drill Diam. Inches | Wire Gage Sizes | Drill Diam. Inches | Wire Gage Sizes | Drill Diam. Inches |
|---|---|---|---|---|---|---|---|
| Z | 0.413 | 1 | 0.2280 | 28 | 0.1405 | 55 | 0.0520 |
| Y | 0.404 | 2 | 0.2210 | 29 | 0.1360 | 56 | 0.0465 |
| X | 0.397 | 3 | 0.2130 | 30 | 0.1285 | 57 | 0.0430 |
| W | 0.386 | 4 | 0.2090 | 31 | 0.1200 | 58 | 0.0420 |
| V | 0.377 | 5 | 0.2055 | 32 | 0.1160 | 59 | 0.0410 |
| U | 0.368 | 6 | 0.2040 | 33 | 0.1130 | 60 | 0.0400 |
| T | 0.358 | 7 | 0.2010 | 34 | 0.1110 | 61 | 0.0390 |
| S | 0.348 | 8 | 0.1990 | 35 | 0.1100 | 62 | 0.0380 |
| R | 0.339 | 9 | 0.1960 | 36 | 0.1065 | 63 | 0.0370 |
| Q | 0.332 | 10 | 0.1935 | 37 | 0.1040 | 64 | 0.0360 |
| P | 0.323 | 11 | 0.1910 | 38 | 0.1015 | 65 | 0.0350 |
| O | 0.316 | 12 | 0.1890 | 39 | 0.0995 | 66 | 0.0330 |
| N | 0.302 | 13 | 0.1850 | 40 | 0.0980 | 67 | 0.0320 |
| M | 0.295 | 14 | 0.1820 | 41 | 0.0960 | 68 | 0.0310 |
| L | 0.290 | 15 | 0.1800 | 42 | 0.0935 | 69 | 0.0292 |
| K | 0.281 | 16 | 0.1770 | 43 | 0.0890 | 70 | 0.0280 |
| J | 0.277 | 17 | 0.1730 | 44 | 0.0860 | 71 | 0.0260 |
| I | 0.272 | 18 | 0.1695 | 45 | 0.0820 | 72 | 0.0250 |
| H | 0.266 | 19 | 0.1660 | 46 | 0.0810 | 73 | 0.0240 |
| G | 0.261 | 20 | 0.1610 | 47 | 0.0785 | 74 | 0.0225 |
| F | 0.257 | 21 | 0.1590 | 48 | 0.0760 | 75 | 0.0210 |
| E | 0.250 | 22 | 0.1570 | 49 | 0.0730 | 76 | 0.0200 |
| D | 0.246 | 23 | 0.1540 | 50 | 0.0700 | 77 | 0.0180 |
| C | 0.242 | 24 | 0.1520 | 51 | 0.0670 | 78 | 0.0160 |
| B | 0.238 | 25 | 0.1495 | 52 | 0.0635 | 79 | 0.0145 |
| A | 0.234 | 26 | 0.1470 | 53 | 0.0595 | 80 | 0.0135 |
| | | 27 | 0.1440 | 54 | 0.0550 | | |

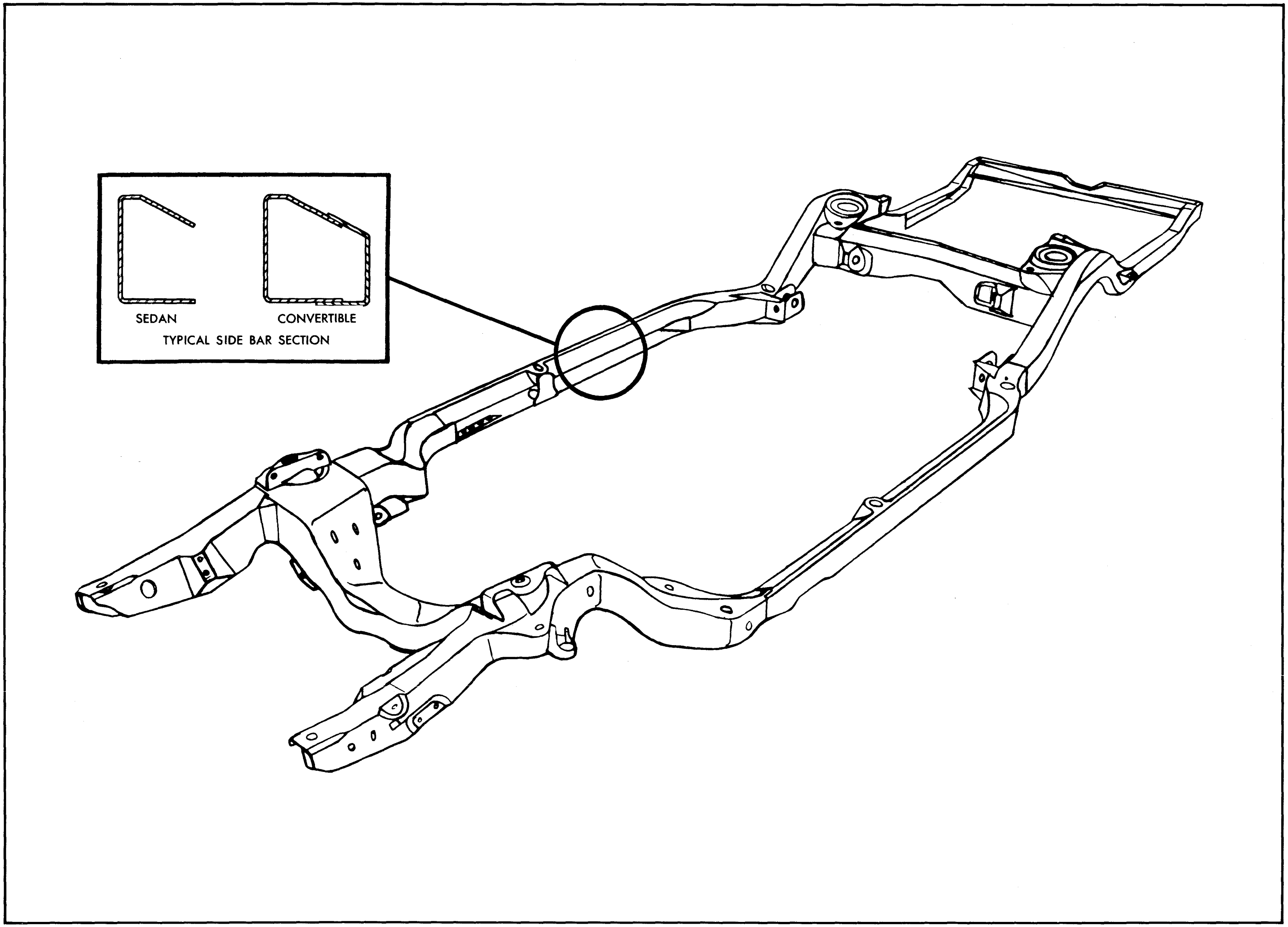



Fig. 1A-1 Perimeter Design Frame

# FRAME AND BODY MOUNTINGS

## GENERAL DESCRIPTION

### *FRAME*

The Tempest swept hip perimeter design frame (Fig. 1A-1) is a basic box configuration with parallel side rails extending just under the inside edges of the body rocker panels. The side rails move inboard front and rear through blended swept hips forming a full box section for front suspension and engine mounting and a kick-up for clearance over the rear suspension.

Three major crossmembers are an integral part of the frame. The rear-most crossmember provides for impact bar attachment provisions and added rear end structural rigidity. The crossmember at the rear kick-up provides for rear suspension mounting and the front crossmember provides for engine and front suspension mounting and over-all structural rigidity. An additional crossmember, mounted in rubber, supports the rear of the transmission. The rubber mounting permits only a minimum transmission of drive train disturbances to the passenger compartment. The radiator baffle and lower support assembly mounts to the extreme front end of the frame through rubber cushions. The main function of this crossmember is to provide support for the sheet metal, but it also adds some structure to the frame assembly.

Two frames designed for optimum tuning are used for all Tempest series models (Fig. 1A-1). The basic frame for the sedans and station wagons has a fully boxed front section and open "C" section center side rails extending to the rear hip area. The convertible frame is of heavier metal thickness and has a boxed section front and center side rail with an additional inner side bar stiffener (boxed section) beginning at the rear end of the rear wheelhouse (number six body bolt) and extending rearward to the rear impact bar attaching bolts.

The dimensions given in Fig. 1A-2 may be used in checking frames.

Dimensions for X, Y and Z are not given, but are used merely to illustrate the points for taking diagonal measurements for checking the squareness of a frame. Holes are located on the frame at the approximate terminal point of the arrowheads, and can be used for this purpose.

### *LIFTING PONTIAC CARS WITH HOISTS*

Lifting can be accomplished without adapters with drive-on type or twin post type hoists, or with hoists or lifts making contact with the front suspension lower arms or rear axle. Since the frame is the perimeter type, some hoists designed to contact side rails require adapters to raise the car without damage to parts of the exhaust system, body, floor, etc. Suppliers of the original lifting equipment should have information on adapters to use with Pontiac cars.

Fig. 1A-3 shows the proper location for placing adapters so that they correctly contact the perimeter

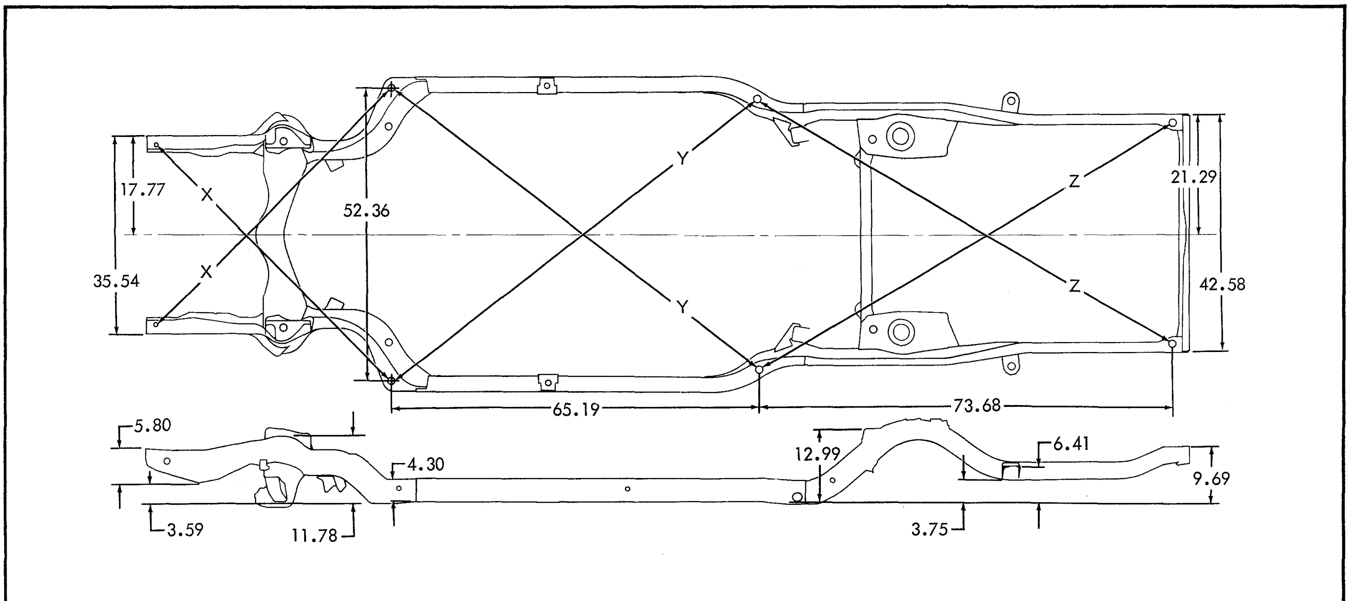



Fig. 1A-2 Frame Checking Chart

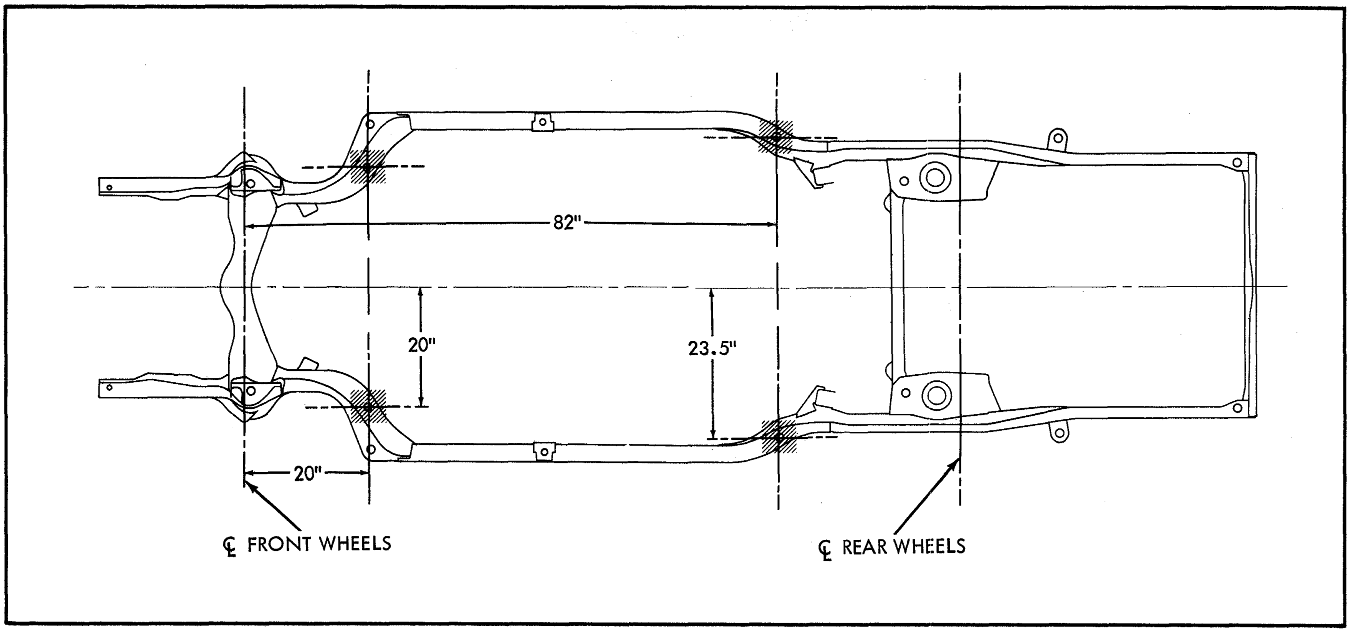



Fig. 1A-3 Proper Location for Adapters

type frame. At front of car, the supports should be 20" behind the center line of the front wheels and 20" to each side of the center line of the car. The rear supports should be placed 82" from the center line of the front wheels and 23.5" to each side of the center line of the car. The clearance at these points is 6.2" at front and 6.3" at rear.

### BODY TO FRAME MOUNTINGS

Total isolation of noise to body interior is accomplished with thick soft butyl rubber mounts (Fig. 1A-4). Seven mounts are used on each side of the body for a total of fourteen mounts per car. All body mounts are the same except the chassis sheet metal mounting and No. 3 mount. The No. 3 body cage nut has a special "T" nut and requires a specific design cushion to accommodate the "T" nut.

A 2-3/16" x 7/16" - 14 hex bolt is used at position No. 3 and a 2-3/8" x 7/16" - 14 hex bolt is used at remaining positions.

All body bolts should be tightened to 25-40 lb. ft. torque.

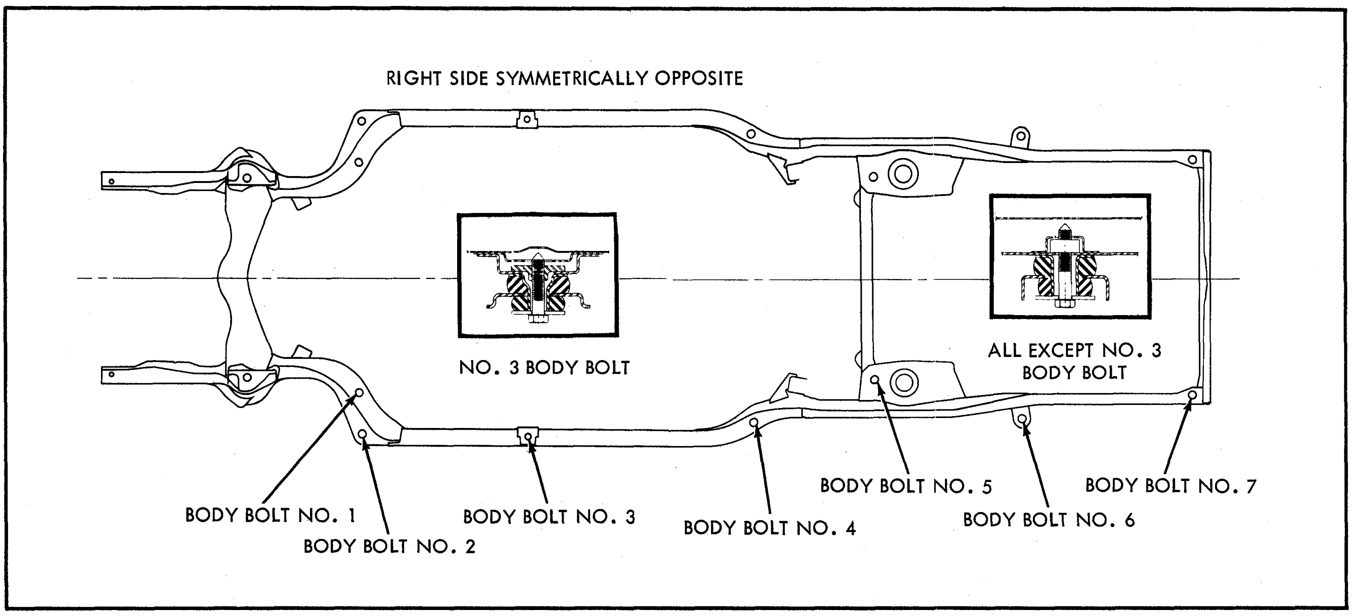



Fig. 1A-4 Location of Body Bolts on Frame

# GENERAL LUBRICATION

## TEMPEST

### CONTENTS OF THIS SECTION



## ENGINE OIL CHANGE

The crankcase of the Pontiac Tempest is filled at the factory with high quality MS oil, specially compounded to ensure proper lubrication of all engine parts during break-in. This oil should be changed after 60 days. Succeeding oil changes should also be made at 60 day intervals, but never to exceed 6,000 miles.

*NOTE: The 1964 Pontiac Tempest is equipped with specially engineered chromium plated piston rings. These rings allow oil to flow freely on the cylinder walls during the break-in period. Therefore oil consumption may be higher during the break-in period than it will be afterward.*

Oil which according to the label on the can is intended for service MS, DG, or HD should be used.

| Atmospheric Temperature Expected | Recommended SAE Viscosity Number | Acceptable Alternate |
|---|---|---|
| Above Freezing (+32° and above) | 20W | 10W-30 |
| Below Freezing (0° to +32°F.) | 10W | 10W-30 |
| Below 0°F. | 5W | 5W-20 |

## LUBRICATION

All Pontiac Tempests are thoroughly and completely lubricated at the factory with a special long lasting chassis lubricant. Under normal conditions chassis lubrication will not be required for 12,000 miles or one year whichever occurs first. For additional extended chassis lubrication periods, special grease part No. 1474829 is recommended. This grease has been specially formulated for your new car, and is available at Pontiac dealers. If conventional chassis lubricant is used, relubrication at 6 months or 6,000 miles, whichever occurs first, is necessary.

## 1964 PONTIAC TEMPEST ITEMS REQUIRING LUBRICATION OR SERVICE AT 6,000 MILE INTERVALS

| | |
|---|---|
| Manifold Heat Control Valve . . . . . . . . . . . . . | Observe for freedom of movement—Lubricate with graphite in alcohol if sticky. |
| Power Steering System and Pump Reservoir . . . . | Add fluid as necessary — Fill reservoir only to mark. Use power steering fluid, part Number 9771864. Replace fluid only if necessary to disassemble. |
| Differential Standard . . . . . . . . . . . . . . . . . | Check for leaks. Refill with hypoid lubricant SAE 90. Change lubricant only when necessary to disassemble. |
| Differential Safe-T-Track . . . . . . . . . . . . . . . . | Check for leaks. Use only Part No. 531536 lubricant. |
| Manual Steering Gear . . . . . . . . . . . . . . . . . | Add lubricant as necessary. Change lubricant only when necessary to disassemble. Use all-season steering gear lubricant. |
| Synchro-Mesh Transmission . . . . . . . . . . . . . | Check for leaks. Use multi-purpose SAE 90 lubricant. Change lubricant only when necessary to disassemble. |
| Clutch-Linkage . . . . . . . . . . . . . . . . . . . . | Check lash and adjust as required at pre-delivery inspection and every 6,000 miles. Engine oil at pivot points, grease at push rod to clutch fork joint, chassis grease at cross shaft pressure fitting. |
| Synchro-Mesh Transmission . . . . . . . . . . . . .<br>Shift Linkage, Column Shift | Engine oil at all joints below steering column shift levers. |
| Synchro-Mesh Transmission . . . . . . . . . . . . .<br>Shift Linkage, Floor Shift | Engine oil at all joints under body. |
| Tires . . . . . . . . . . . . . . . . . . . . . . . . . | Rotate tires every 6,000 miles, and balance in new position. |
| Brake System and Master Cylinder Reservoir . . . . | Check system for adequate brake pedal reserve and for evidence of leaks, correct, use GM or Delco Super II or any SAE 70R1 Brake Fluid. |

## 1964 PONTIAC TEMPEST ITEMS REQUIRING LUBRICATION OR SERVICE AT 6 MONTHS OR 6,000 MILE INTERVALS, WHICHEVER OCCURS FIRST

| | |
|---|---|
| Engine Oil Filter . . . . . . . . . . . . . . . . . . | Replace oil filter every 6 months or 6,000 miles, whichever occurs first. |
| Standard Carburetor Air Cleaner Element . . . . . . | Clean and re-oil using engine oil. Clean and re-oil after each occasion of driving under severe dust conditions.<br>*NOTE: Heavy-duty type recommended for continuous operating under severe dust conditions.* |

| | |
|---|---|
| Hood Latch Assembly | Engine oil on pivots and spring anchor points, light grease on release pawl, every 6 months and as required. |
| Hood Hinges | Engine oil on hinge pins and spring anchor points every six months and as required. |

## 1964 PONTIAC TEMPEST ITEMS REQUIRING LUBRICATION OR SERVICE AT SIX MONTHS OR 12,000 MILE INTERVALS, WHICHEVER OCCURS FIRST

| | |
|---|---|
| Accelerator Linkage | Engine oil at all pivot points. Do not lubricate the linkage which is a part of the carburetor assembly. |
| T. V. Linkage | Engine oil, do not lubricate carburetor linkage. |
| Automatic Transmission Shift Linkage | Lubricate with engine oil at all joints below steering column except rubber grommets. |
| Air conditioning | Check refrigeration system sight glass for proper quantity of Freon charge (with engine running, A.C. turned on, and over 70° ambient air temperature). A clear glass indicates a solid column of Freon in a system which is operating properly. |

## 1964 PONTIAC TEMPEST ITEMS REQUIRING LUBRICATION OR SERVICE YEARLY OR 12,000 MILES, WHICHEVER OCCURS FIRST

| | |
|---|---|
| Crankcase Inlet Vent and Oil Filler Cap | Clean and re-oil with engine oil.<br>*NOTE: Clean and re-oil after each occasion of driving under severe dust conditions.* |
| Positive Crankcase Vent | Replace valve assembly yearly or every 12,000 miles, whichever occurs first. |
| Heavy Duty Air Cleaner | Wash element in solvent and re-oil with 10W-30 engine oil.<br>*NOTE: Clean and re-oil after each occasion of driving under severe dust conditions.* |
| Fuel Filter — Integral | Clean yearly. |
| Chassis Lubrication | For additional extended chassis lubrication periods, Special Pontiac Chassis Grease Part No. 1474829 is recommended. This grease has been specially formulated for your new car, and is available at Pontiac dealers. If conventional chassis lubricant is used, relubrication at six months or 6,000 miles is necessary. |

## 1964 PONTIAC TEMPEST ITEMS REQUIRING LUBRICATION OR SERVICE EVERY TWO YEARS OR 24,000 MILES, WHICHEVER OCCURS FIRST

| | |
|---|---|
| Automatic Transmission | Replace transmission oil. Refill with Hydra-Matic Fluid AQ-ATF, Type "A". Under heavy duty operation conditions or excessive stop and go driving replace transmission oil at 12,000 mile intervals. |

## 1964 PONTIAC TEMPEST ITEMS REQUIRING LUBRICATION OR SERVICE AT SPECIAL INTERVALS

| | |
|---|---|
| Parking Brake Cable . . . . . . . . . . . . . . . . . | Clean and relubricate at time rear brake drums are removed for major brake service — Use light grease. |
| Speedometer Cable . . . . . . . . . . . . . . . . . . | If noise or needle flicker occurs — lubricate — use speedo cable grease. |
| Front Wheel Bearings . . . . . . . . . . . . . . . . | Lubricate only when wheels are off for other service — Use special hi-temperature wheel bearing grease, use only enough lubricant to thoroughly coat the rollers, do not fill the wheel hub cavity. |
| Body Door Locks and Strikers . . . . . . . . . . . . | Stick type lubricant, use sparingly as required. |
| Door Hinge Hold-Opens . . . . . . . . . . . . . . . | Light grease on friction surfaces — Use sparingly as required. |
| Body Door Hinge Pins . . . . . . . . . . . . . . . . | Engine oil as required. |
| Station Wagon Tail Gate Hinge and Linkage . . . . . . . . . . . . . . . | Engine oil as required. |
| Station Wagon Folding Seat . . . . . . . . . . . . . . | Engine oil on pivots (use sparingly as required). |
| Fuel Door Hinge . . . . . . . . . . . . . . . . . . . | Engine oil on hinge pin and spring anchor points as required. |
| Battery . . . . . . . . . . . . . . . . . . . . . . . | Add distilled water every 30 days. May require more frequent additions during high ambient temperatures and/or extended trip operation. Clean terminals yearly and apply petrolatum. |
| Air Conditioning . . . . . . . . . . . . . . . . . . . | Operate air conditioning system for a minimum of 5 minutes every month, even in winter. This will supply oil to the compressor shaft seal. |
| Air Conditioning Condenser Core . . . . . . . . . . | Clean off leaves, bugs, etc. and flush outside of condenser and radiator core to remove dirt — yearly and each spring. *CAUTION: Do not use steam.* |

# SUSPENSION

## CONTENTS OF THIS SECTION



## DESCRIPTION

The suspension system employs coil springs front and rear. Ball joints are used on the steering knuckle at the outer ends of the upper and lower control arms.

The rear suspension consists of a basic four-link suspension, made up of two lower control arms, one on each side, and two upper control arms which are held by pivot bolts at the rear axle and frame cross member.

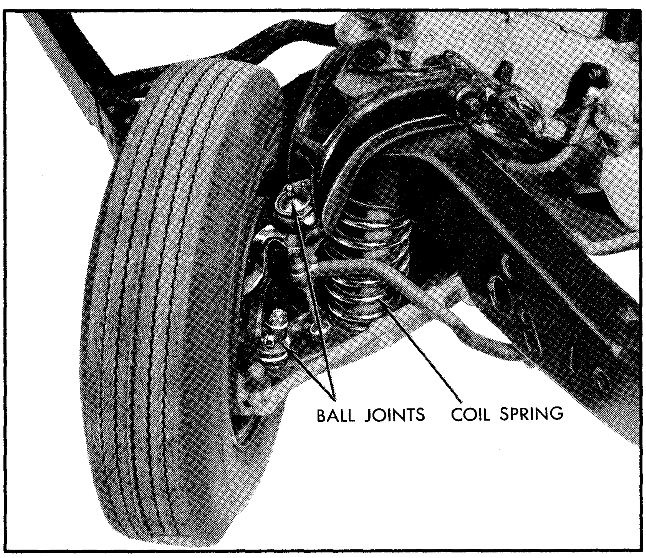



Fig. 3-1 Front Suspension Ball Joints

### FRONT SUSPENSION

The ball joints, located at the outer ends of the upper and lower controls arms (Fig. 3-1), serve as pivot points for both the vertical movement of the wheel and rotation of the steering knuckle. The ball joint assemblies have a "fixed boot" grease seal for protection against dirt and water entry (Fig. 3-2). The spherical joints take thrust from any angle. The steering knuckles and spindles are of integral design and the brake cylinders are rigidly attached to the knuckles with the backing plate serving principally as a support for brake shoes and as a protective cover (Fig. 3-3).

Rubber bushings at the inner ends of the upper

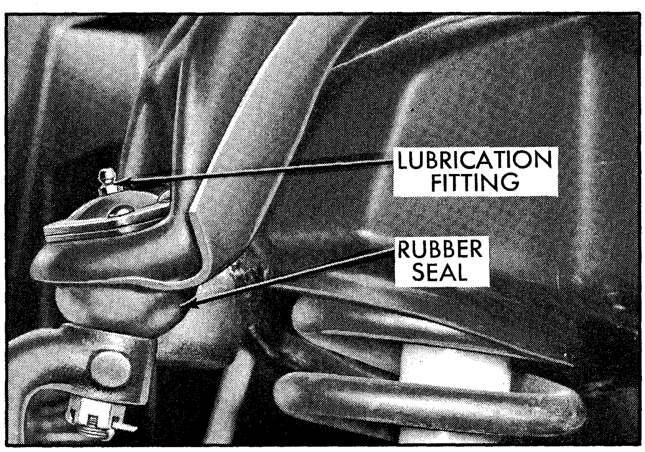



Fig. 3-2 Upper Control Arm Lubrication Fitting

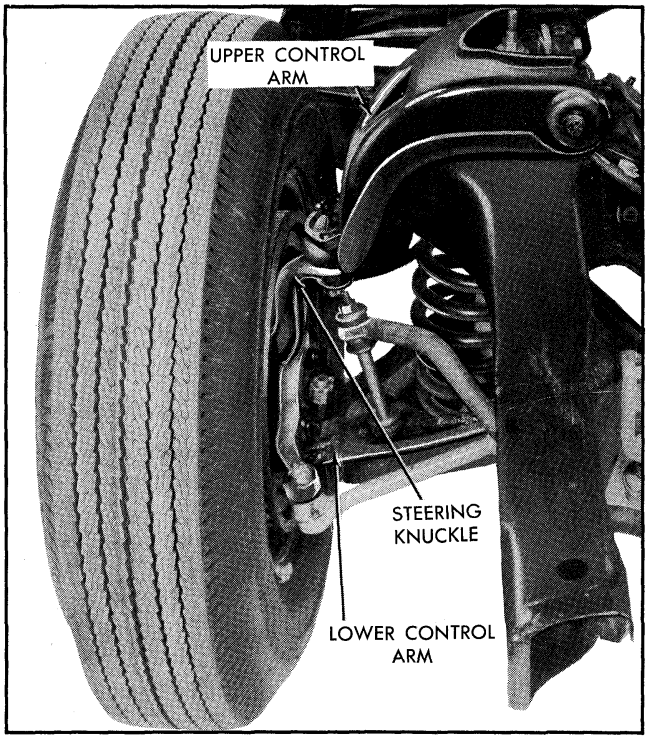



Fig. 3-3 Attachment of Front Suspension to Wheel

control arms pivot on shafts attached to the car frame. Caster and camber adjustments are made with shims at this point (Fig. 3-4).

The inner ends of the lower control arms are rubber mounted to the front cross member and frame brackets thus avoiding metal to metal contact.

The upper ends of the front coil springs seat in the frame side members; the lower ends of these springs rest on the lower control arms (Fig. 3-1).

A direct acting double action shock absorber is carried inside each front coil spring. The upper stud of the shock absorber is fastened to a bracket on the frame by a nut. The lower end of shock absorber is attached to the lower control arm with two bolt and washer assemblies. Noise insulation is provided by rubber bushings which fit over the shock absorber upper studs to prevent metal to metal contact between each stud and metal bracket.

A stabilizer shaft, mounted in rubber to the frame forward of the front springs and connected to the lower control arms by links at each end, provides roll stability (Fig. 3-5).

Rubber bumpers attached to the frame below the upper control arm cushion downward movement of the suspension system, and bumpers attached to the front lower control arms cushion the upward movement.

***REAR SUSPENSION***

The two rear axle upper control arms and two lower control arms (Fig. 3-6) form the basic links of rear suspension. The function of the control arms is to keep the geometry relationship of the rear axle with respect to the frame, provide for optimum handling and oppose torque reaction on both acceleration and braking.

Rubber bushings are used at all connecting pivot points of the two upper and two lower control arms.

The upper ends of rear springs are retained in seats welded to the frame while the lower ends are attached to brackets welded to the rear axle (Fig. 3-7).

Direct acting double action shock absorbers are mounted with upper ends inclined toward center of

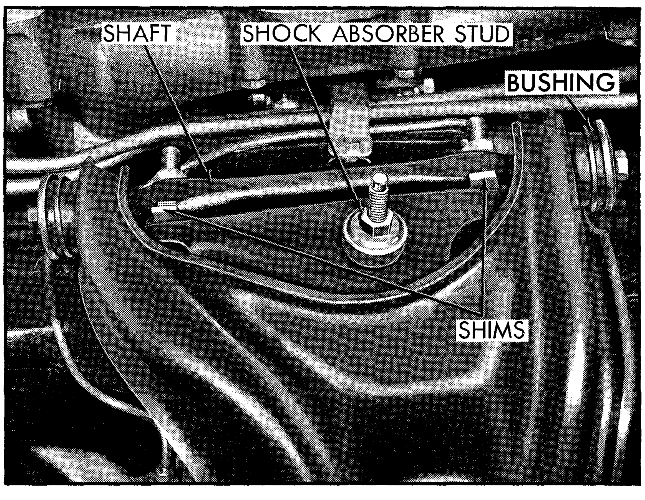



Fig. 3-4 Shimming of Upper Control Arm

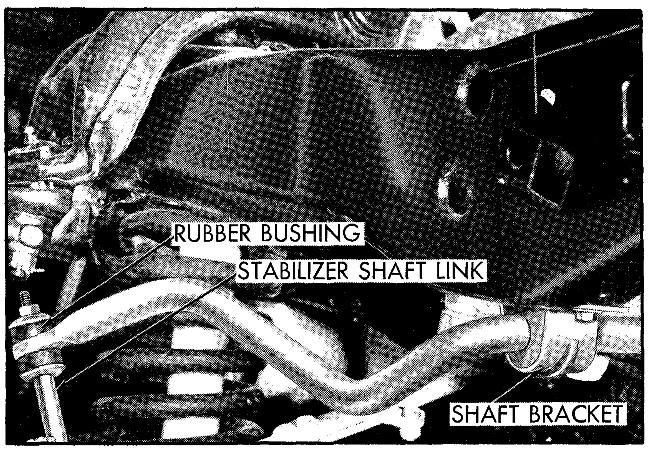



Fig. 3-5 Stabilizer Shaft Assembly

car. Rubber bumpers, attached to the rear axle, cushion extreme downward movement of the frame and body.

## PERIODIC SERVICE

Periodic service of the suspension system consists of regular lubrication as outlined in the GENERAL LUBRICATION section.

Lubrication fittings are provided at the front suspension ball joints for service lubrication at the recommended interval. Grease seals are constructed with one-way relief valves which provide for the escape of old grease and a thorough flushing of the joints on being lubricated. Shock absorbers do not require lubrication and, in case of leaks or malfunction, they should be replaced.

## ADJUSTMENTS AND CHECKS ON CAR

The following adjustments and checks are made with the suspension parts on the car:

### CHECK AND ADJUST FRONT WHEEL BEARINGS

*NOTE: Tapered roller bearings have a slightly loose feel when properly adjusted. This differs from ball bearings which may be pre-loaded without adverse effect. Tapered roller bearings can be damaged by the steady thrust on roller ends which comes from pre-loading.*

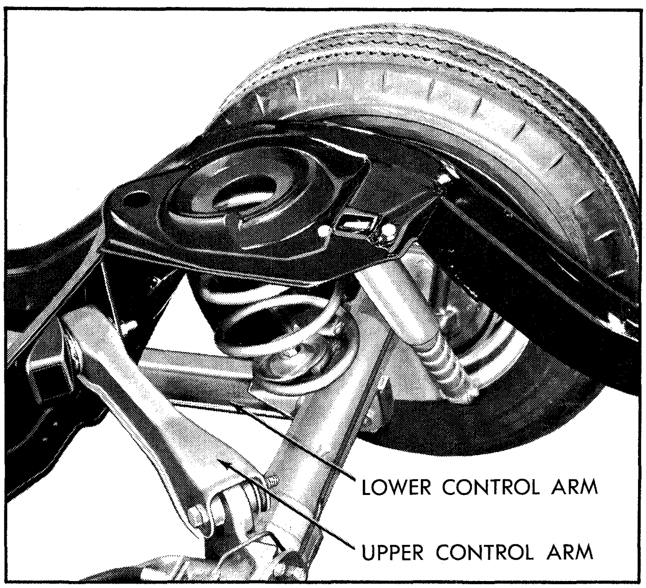



Fig. 3-6 Upper and Lower Rear Control Arms

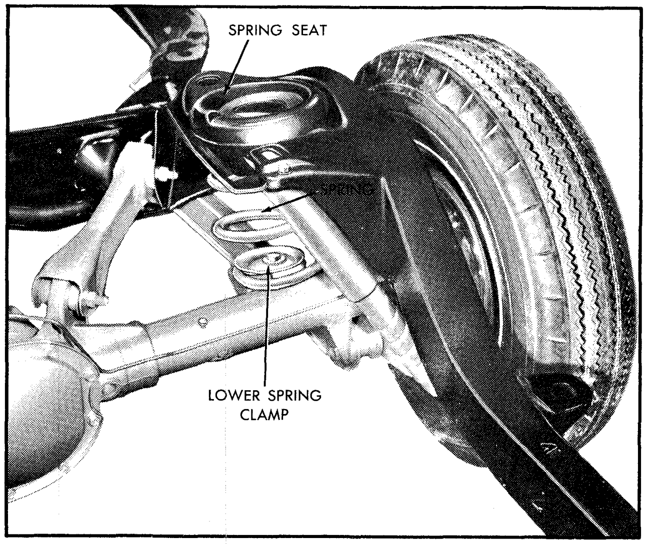



Fig. 3-7 Position of Rear Coil Spring

To Check:

1. Place lift or car jack under lower frame front cross member and raise wheel off floor. This will maintain load on the ball joints.

2. Spin wheel to check for unusual noise.

3. Grip tire at top and bottom and rock. If movement of tire at outer edge exceeds 1/4", the wheel bearing may be excessively loose. If bearings are noisy or looseness is excessive, they should be cleaned and inspected prior to adjustment.

TORQUE WRENCH METHOD (Preferred)

1. Remove dust cap.

2. Check for slip fit of bearing cones on spindles. Bores of bearing cones should have a light coat of wheel lubricant to allow cones to creep on spindle.

3. If nut turns hard on spindle, check for and remove any burrs from spindle threads and cotter pin holes or key slot in nut.

4. With tire off ground, adjust bearing as follows:

   a. While rotating tire, tighten nut with torque wrench to approximately 10-12 lb. ft. to insure all parts are properly seated.

   b. Back off nut one flat (1/6) of a turn. If locking holes line up, insert cotter pin. If holes do not line up, continue to back off the adjusting nut to the nearest locking hole. Final adjustment should be

one flat to 1-1/2 flats backed off from the initial tightened position. This should result in the desired limits of .001"-.010" end play. Nut should be finger loose.

c. Clinch cotter pin and cut off extra length to ensure ends will not interfere with static collector or dust cap.

5. Install dust cap and lower tire to ground.

HAND FEEL METHOD (Optional)

1. Remove dust cap.

2. Check for slip fit of bearing cones on spindles. Bores of bearing cones should have a light coat of wheel bearing lubricant to allow cones to creep.

3. If nut turns hard on spindle, check for and remove any burrs from spindle threads and cotter pin holes or key slots in nut.

4. With tire off ground, adjust as follows:

a. Tighten nut with 8" or 10" wrench using enough arm length leverage to ensure parts are properly seated while spinning wheel.

b. Back off nut finger loose, then tighten finger tight.

c. If hole in spindle lines up with slot in nut, install cotter pin. If not, back off to next slot and install cotter pin.

d. Clinch cotter pin and cut off extra length to ensure ends will not interfere with static collector or dust cap.

5. Install dust cap and lower tire to ground.

### CHECK BALL JOINTS

1. Check and lubricate all ball joints. Insure that lubricant used meets current Pontiac extended interval specifications.

2. Raise car at the lower control arm, supporting outside of the spring seat, so that the upper control arm is not touching rebound rubber bumper and front wheels are free from contact with lift or floor.

3. Remove dust cap, wheel bearing nut cotter pin, and temporarily tighten nut just enough to remove all end play from wheel bearings.

*CAUTION: It is imperative that the wheel bearing nut be loosened and the wheel bearing readjusted according to the procedure outlined under "Check and Adjust Front Wheel Bearing," after the ball joint check is completed.*

4. Check movement of each front wheel by moving top and bottom of tire in and out, using sufficient hand load to take up any clearance, but not in excess to deform tire or suspension parts. An excess of 1/4" travel (measured at the periphery of the tire) indicates a worn or loose wheel bearing, worn ball joints, looseness at the upper or lower control arm shafts, or a combination of all these. When moving tire, as mentioned above, observe each ball joint and each bushing on upper arm shaft to check each part independently for looseness.

5. If above check indicates looseness, check wheel bearings using torque wrench or hand feel method. Replace bearings if worn excessively.

6. If wheel bearings or upper arm shafts were not the cause of looseness, use J-6627 ball stud remover to remove the upper ball stud, and disconnect the upper arm from steering knuckle.

7. Make sure that the upper ball joint is properly lubricated, then install a nut (snug against the upper ball joint) and rotate the ball stud in its socket with a torque wrench. If the torque required is less than 1/2 lb. ft. or more than 6 lb. ft. the ball joint should be replaced.

8. Install upper ball stud in knuckle and tighten stud nut to 55-70 lb. ft. torque.

9. If excessive looseness still exists at periphery of tire, then use J-6627 ball stud remover to disconnect lower ball stud from steering knuckle.

*NOTE: It is permissible to support the suspension assembly anywhere on the lower arm.*

10. Install nut on lower ball stud and check for excessive wear or looseness by measuring the ball joint end play.

a. When the ball joint is new, it is permissible to have a maximum of .010" end play.

b. When checking a used or worn ball joint, it is permissable to have a maximum of .060" end play.

11. Replace lower ball joint in control arm, if necessary.

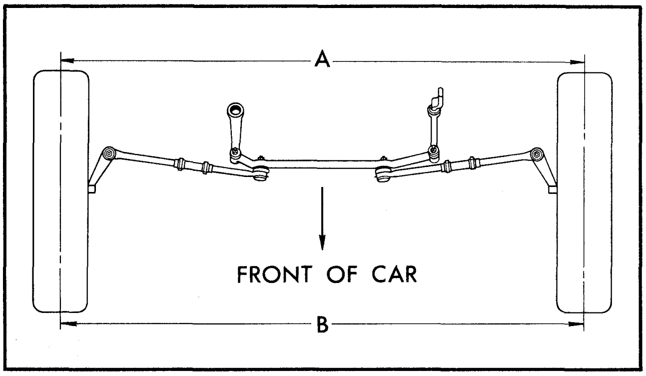



Fig. 3-8 Toe-In

12. Install lower ball stud in knuckle and tighten stud nut to 85-100 lb. ft. torque.

## WHEEL ALIGNMENT—DEFINITIONS

### *TOE-IN*

Toe-in is the drawing together of the front wheels so that they are closer at the front "B" than at the back "A" as shown in Fig. 3-8.

### *CASTER AND CAMBER*

Forward tilt of the front ball joints relative to the true vertical is negative caster; backward tilt is positive caster (Fig. 3-9). Camber is the outward tilt of front wheels at top (Fig. 3-10).

### *TOE-OUT ON TURNS*

Toe-out on turns is the relationship between front wheels on turns (Fig. 3-11). Since the front wheels must turn on different radius circles, the steering arms are inclined inward at the back to provide the correct turning angles in degrees.

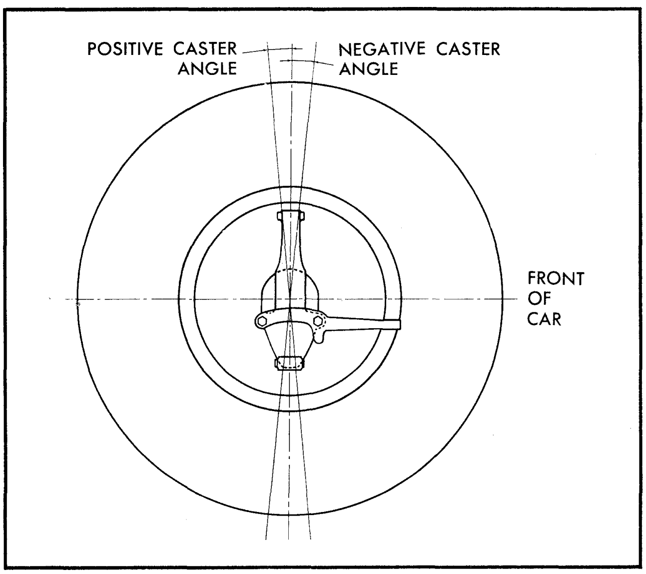



Fig. 3-9 Caster Angle

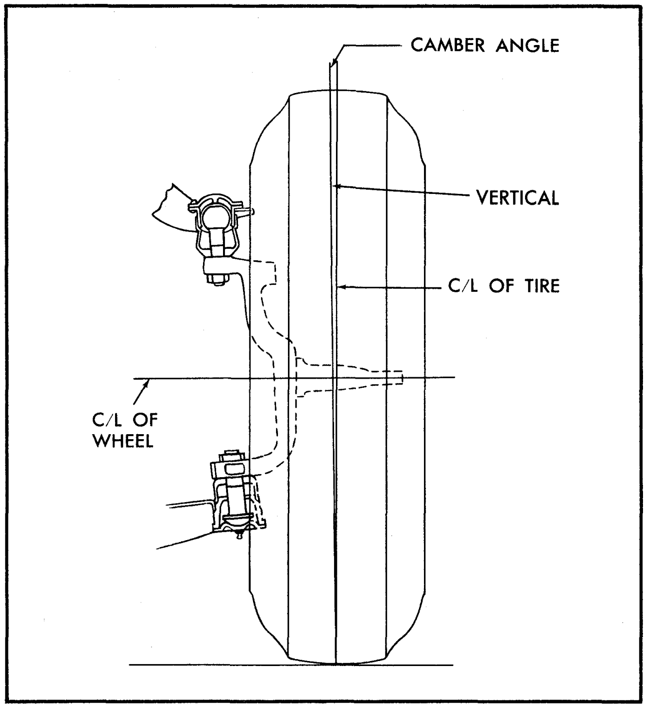



Fig. 3-10 Camber Angle

## INSPECTION BEFORE CHECKING FRONT WHEEL ALIGNMENT

Before any checking or corrective work is started on wheel alignment elements, including toe-in, caster, camber and toe-out on turns, the following items which will affect steering should be considered:

1. Check tire inflation and bring to recommended pressure.

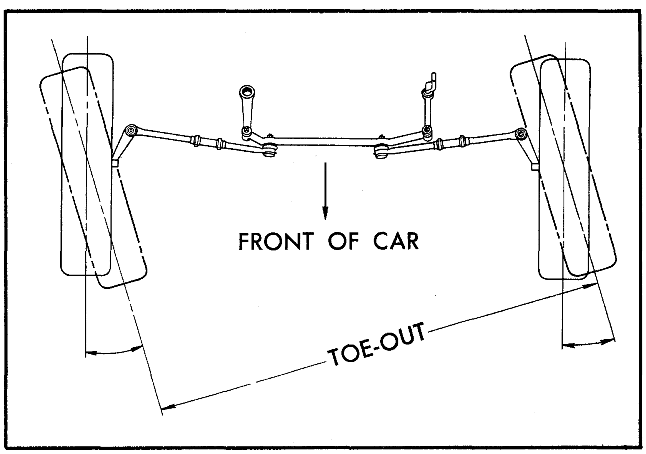



Fig. 3-11 Toe-Out on Turns

2. Check front wheel bearing adjustment and correct if necessary.

3. Check wheel and tire run-out and balance.

4. Check ball joints.

5. Check steering linkage for looseness. Replace or tighten parts.

6. Check shock absorbers for leaks or lack of control.

7. Check for extraordinary load in car. Remove load or compensate by setting height. (Samples, tools, etc., carried regularly should not be considered extraordinary load.)

8. The suspension parts must be at normal curb load position before alignment. Curb load is defined as car with full tank of gasoline and unoccupied.

To determine whether car is at normal curb load, compare height measurement on the car in question with others of the same body style and having comparable equipment. The front and rear of car should be jounced up and down, decreasing the amount of movement until the suspension parts are equalized, before any measurements are made.

### CHECK AND SET TOE-IN

Check and set toe-in (see SPECIFICATIONS) with a trammel or with other reputable front end aligning equipment, measuring from sidewall of tire or wheel felloes using methods given below.

MEASURING BY TRAMMEL

1. After moving car forward on level floor, chalk tread on both front tires at point 9" above floor.

2. With trammel set at center to center distance of front tires, make mark with chalk on each front tire exactly trammel width apart.

3. Push car forward (never backward) until chalk with trammel marks is 9" above floor at rear of wheels.

4. Measure difference from trammel marks made when chalk was in front of wheel; if trammel marks are now greater than when marked at front, wheels toe-in by this amount (see SPECIFICATIONS).

EQUIPMENT MEASURING FROM SIDEWALL OR WHEEL FELLOES

When using this type of equipment, wheel run-out will have a very direct bearing on the readings. Since the allowable run-out is 1/8" the readings could possibly be off as far as 1/8" on each wheel if the effect of run-out is not cancelled. By taking the average of three readings with the wheel rotated 120° for each reading, the error due to wheel run-out can be cancelled. This should be done as follows:

1. After moving the car forward on level floor, take first reading.

2. Mark sidewall of both tires with the number "1" at rear of tire where instrument bears.

3. At 120° intervals (i.e. 1/3 and 2/3 distance around the tire) mark the numbers "2" and "3" on both tires.

4. Jack up and turn wheels until the number "2" is in the position which number "1" occupied when the first reading was taken.

5. Push car back one foot and bring forward to position and take second reading. This reading will then be taken with the instrument bearing 120° around the wheel from where the first reading was taken.

6. Use the same procedure for taking the third reading.

7. Average the three readings to find the actual toe-in.

### SET TOE-IN

1. Remove horn button and set gear on high point of worm by turning steering wheel until mark on shaft is exactly at top. This mark locates the high point, or middle of gear travel.

2. Loosen tie rod end clamp bolts and turn tie rod tubes an equal amount until toe-in is 0-1/8". Turn right tie rod in direction of rotation of wheels, when car moves forward, to increase toe-in; turn left tie rod in opposite direction to increase toe-in.

3. Make sure front wheels are straight ahead by measuring from a reference point at same place on each side of frame center to front of wheel rims. If measurements are not equal, turn both tie rod tubes in same direction (so as not to change toe-in) until

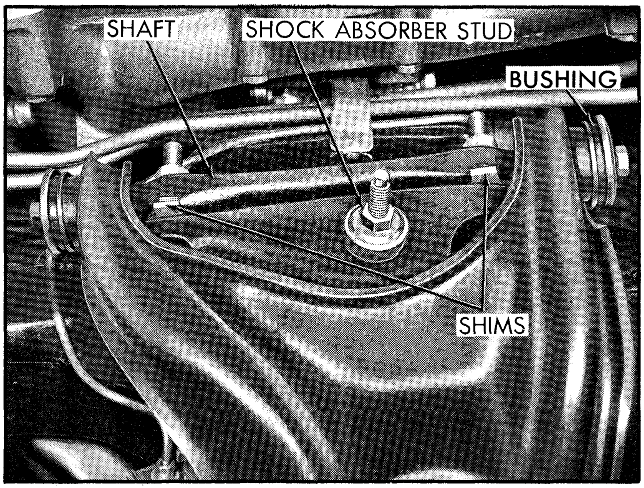



Fig. 3-12 Caster and Camber Shim Location

measurements become equal. Re-check toe-in since toe-in measurement is accurate only with wheels in straight-ahead position.

4. Tighten tie rod adjuster sleeve bolts to 14-20 lb. ft. torque, making sure bolts are to lower rear side of tie rod.

### ADJUST CASTER AND CAMBER

Caster and camber are adjusted to specifications by placing shims between the upper pivot shafts and the frame (Fig. 3-12). Both adjustments can be made at the same time. In order to remove or install shims, raise car to remove weight from front wheel then loosen the control arm shaft to frame bolts. Addition to camber angle moves top of wheel out-subtraction in.

1. To decrease positive caster add shims to front bolt.

2. To increase positive caster remove shims from front bolt.

3. To increase camber remove shims from both front and rear bolts.

4. To decrease camber add shims to both front and rear bolts.

5. Compensate for drift to right due to road camber by setting left camber angle 1/4° greater than right.

*NOTE: By adding or subtracting an equal amount of shims from front and rear bolts camber will be changed without affecting caster.*

After the correct number of shims have been installed, torque the pivot shaft mounting bolts to 55-75 lb. ft.

### CHECK TOE-OUT ON TURNS

Check toe-out after any necessary corrections to camber, caster, and toe-in have been made.

1. Check with any reputable front end aligning equipment using full floating turn tables. With front wheels resting on turn tables, turn wheels to left until left wheel has been turned 20° from straight ahead. The right wheel should then be turned 18° to 19°.

2. Turn wheels to right until right wheel has been turned 20° from straight ahead. Left wheel should now be turned 18° to 19°.

3. Incorrect toe-out on turns may be caused by other incorrect front end adjustments, but generally indicates bent steering arms which must be replaced.

Replacement of one or both steering arms should be followed by a complete front end check.

## MINOR REPAIRS

### FRONT WHEEL BEARING REPLACEMENT

1. Insert a brass drift through hub, indexing end of drift with notches in hub shoulder behind bearing cup.

2. Tap lightly on cup, alternating through each notch, to remove cup from hub.

3. Install new bearing cup in hub using Tool J-8849 on the outer race and Tool J-8914 on the inner race. Tool J-8092, Driver Handle must be used with the above installers.

4. Make certain that the cup is not cocked and that it is fully seated against shoulder in hub.

### FRONT SHOCK ABSORBER—REMOVE AND REPLACE

1. Raise car on hoist, or jack up front end so weight of car is fully off front wheels.

2. Remove nut, retainer and grommet which attach upper end of shock absorber to frame bracket.

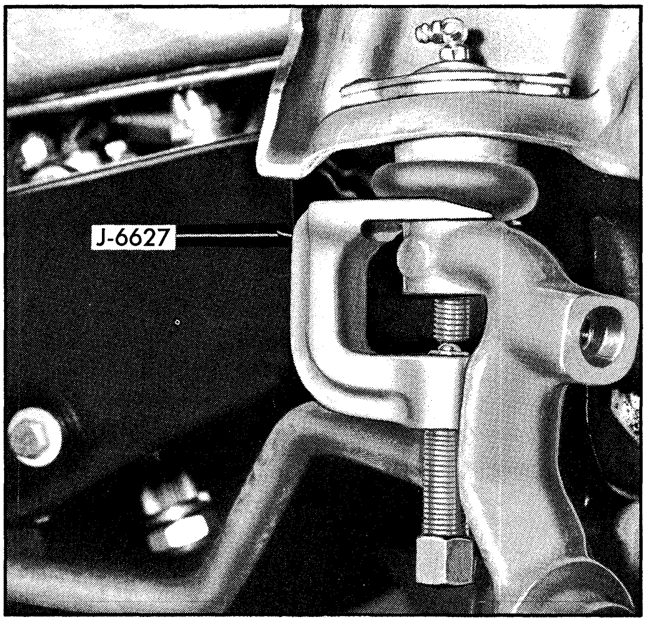



Fig. 3-13 Pressing Ball Stud from Steering Knuckle

*NOTE: Shock absorber piston rod must not turn while loosening nuts. If necessary, use pliers or wrench to hold top of shock absorber stud mounting while removing nuts.*

3. Remove two lower bolts and washer assemblies retaining shock absorber and remove shock absorber through lower control arm.

4. Install by reversing above procedure. Make sure all grommets and retainers are correctly installed.

*NOTE: Upper stud nut must be pre-tightened until it bottoms at end of steel threads.*

5. Tighten upper stud nut 60-120 lb. ft. torque and lower bolts 15-25 lb. ft. torque.

## FRONT SPRING—REMOVE AND REPLACE

1. Raise front end of car supporting so that lower control arm hangs free.

2. Remove wheel.

3. Remove shock absorber.

4. Disconnect stabilizer link from lower control arm.

5. Disconnect tie rod from steering arm.

6. Support under control arm.

7. Disconnect upper and lower ball stud from steering knuckle using tool J-6627 (Fig. 3-13) and remove brake drum and steering knuckle as an assembly.

*CAUTION: Brake line is still connected. Support drum so that line is not damaged.*

*CAUTION: Ball stud rubber seal is not serviced. Removal or damage to seal necessitates replacement of complete ball stud assembly.*

8. Carefully lower arm until spring is free.

9. Install by reversing removal procedure.

Tighten shock absorber lower bolts to 15-25 lb. ft. torque.

Tighten stabilizer link nut to 60-120 lb. in. torque.

Tighten tie rod to steering arm nut to 30-45 lb. ft. torque.

Tighten upper ball stud retaining nuts to 55-70 lb. ft. torque and lower to 85-100 lb. ft. torque.

## FRONT UPPER CONTROL ARM, SHAFT AND BUSHINGS—REMOVE AND REPLACE

1. Place jack under lower control arm, raise wheel off floor and remove.

2. Remove upper ball stud from steering knuckle, using tool J-6627.

3. Remove two bolts and self locking nuts holding control arm shaft to frame and remove arm and shaft assembly.

4. Remove bolts and retainers from pivot shaft ends.

5. Replace one bolt at either end of cross shaft.

6. Set up control arm as shown in Fig. 3-14 and install Spacer J-9502.

7. Invert control arm for bushing removal as shown in Fig. 3-15 with retainer bolt in opposite end of shaft and press out with arbor. Other bushing may be removed in same manner.

8. Install shaft in control arm as follows:

a. Place tool J-7167 in position (Fig. 3-17) and expand until distance between outer faces of arm is 9-3/4" (Fig. 3-16).

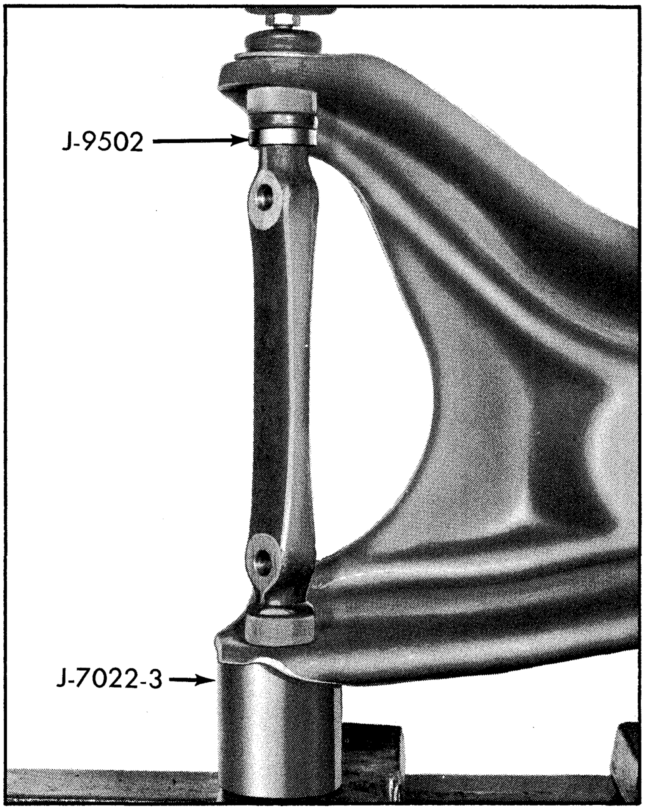



Fig. 3-14 Installing Spacer

b. Position pivot shaft in control arm.

c. Insert bushings on ends of shaft.

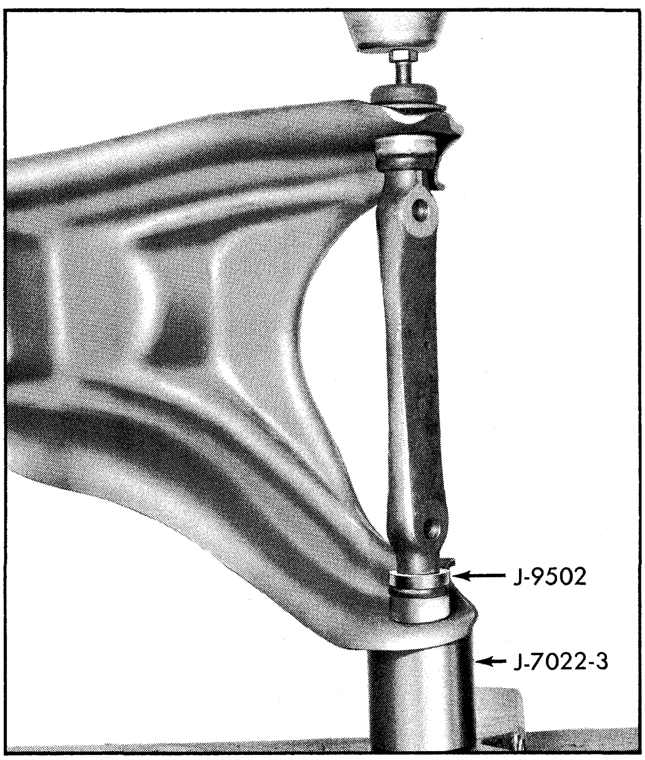



Fig. 3-15 Removing Bushing

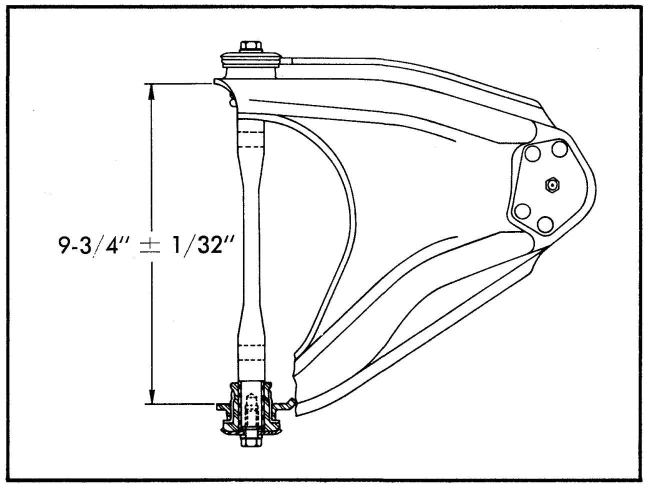



Fig. 3-16 Correct Installation of Upper Control Arm Shaft

d. Press bushings in control arm with arbor using two J-9502-1 Installers as shown in Fig. 3-17.

e. Install retainers and nuts on ends of shaft, tighten nuts finger tight.

f. Line up pivot shaft by rotating shaft in bushing so that frame mounting holes in shaft line up as shown in Fig. 3-16.

g. Tighten bolts to 35-45 lb. ft. torque.

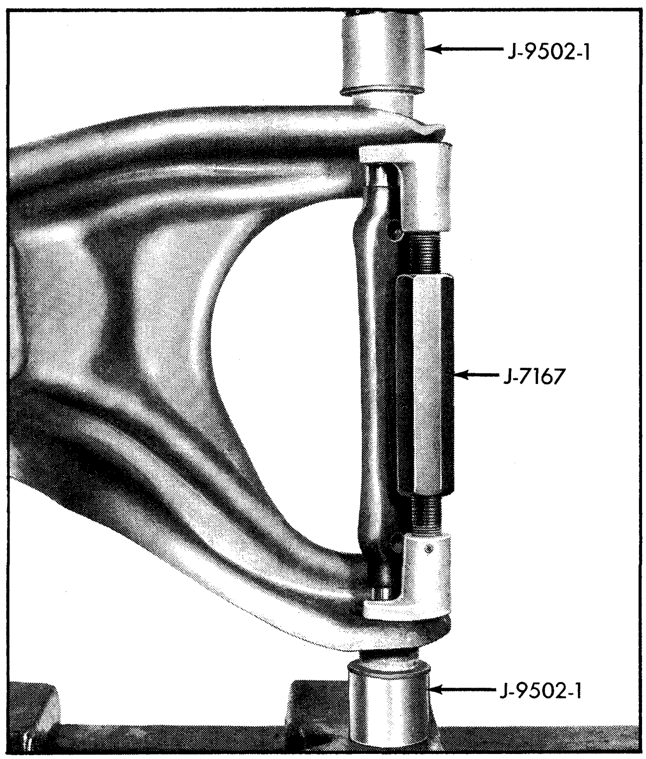



Fig. 3-17 Install Front Upper Control Arm Bushings

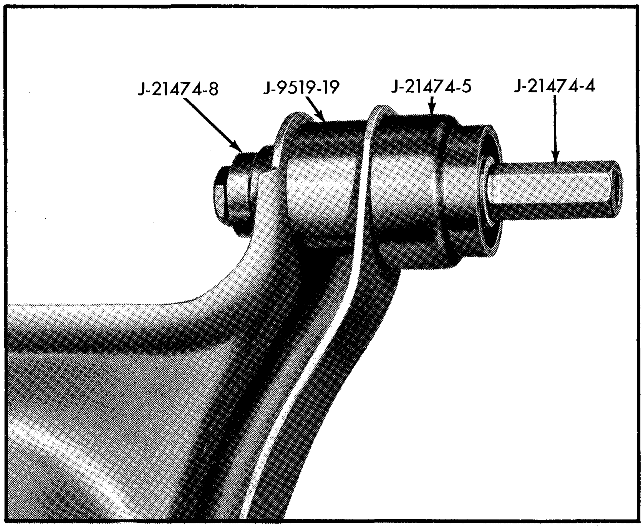



Fig. 3-18 Removing Rear Bushing from Front Lower Control Arm

9. Position upper control arm and shaft on frame cross member and install two bolts and self locking nuts. Tighten nuts to 55-75 lb. ft. torque.

10. Connect upper ball stud to steering knuckle tightening stud nut to 55-70 lb. ft. torque.

11. Replace wheel, lower car and check front wheel alignment.

### *FRONT LOWER CONTROL ARM— REMOVE AND REPLACE*

1. Remove spring as outlined above.

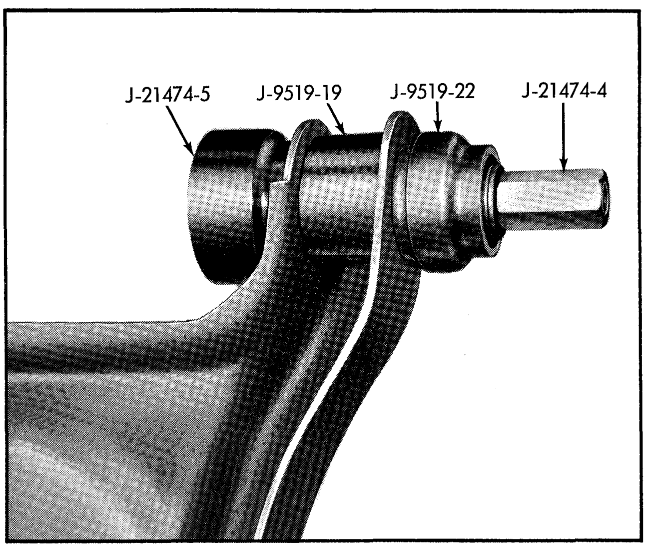



Fig. 3-19 Installing Rear Bushing in Front Lower Control Arm

2. Disconnect inner ends of lower control arms by removing pivot bolts.

3. Install by reversing removal procedure. Tighten pivot bolts 75-100 lb. ft. torque.

### *FRONT LOWER CONTROL ARM REAR BUSHING— REMOVE AND REPLACE*

1. Support car under frame at front of siderail.

2. Place support under control arm relieving tension on pivot bolts and remove rear pivot bolt. Lower arm and block to provide access to bushing.

3. Remove bushing using tool J-21474 as shown in Fig. 3-18.

4. Install new bushing in control arm using components of tool J-21474 as shown in Fig. 3-19.

### *FRONT LOWER CONTROL ARM FRONT BUSHING— REMOVE AND REPLACE*

1. Support car under frame at front of siderail.

2. Place support under control arm relieving tension on pivot bolts and remove front pivot bolt. Lower arm and block to provide access to bushing.

3. Remove bushing using tool J-21474 as shown in Fig. 3-20.

4. Install new bushing in control arm using components of tool J-21474 as shown in Fig. 3-21.

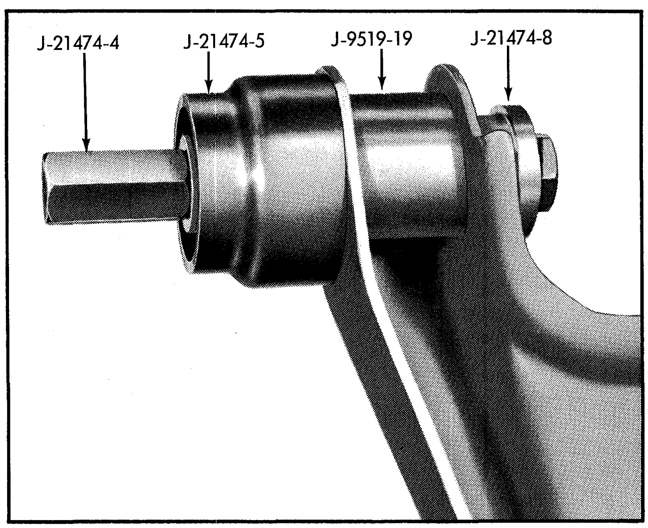



Fig. 3-20 Removing Bushing from Control Arm

***UPPER BALL JOINT REMOVE AND REPLACE***

1. Raise car supporting under control arms.

2. Remove upper ball stud retaining nut and remove stud from knuckle using tool J-6627.

3. Remove ball stud from upper arm by chiseling or drilling rivet heads which retain ball joint in arm.

4. Install new ball joint, retaining with special bolts, nuts and washers supplied with new joints.

*CAUTION: Use only special alloy bolts supplied with stud package for this operation.*

5. Torque nuts to 10-12 lb. ft.

***LOWER BALL JOINT REMOVE—CONTROL ARM ON CAR***

1. Raise car supporting under lower control arms and remove wheel.

2. Disconnect tie rod from steering arm.

3. Disconnect upper and lower ball stud from steering knuckle using tool J-6627 (Fig. 3-13) and remove brake drum and steering knuckle as an assembly.

*CAUTION: Brake line is still connected. Support drum so that line is not damaged.*

4. Remove grease seal and drive lower ball joint from control arm using drift. Drive alternately on either side of ball stud housing.

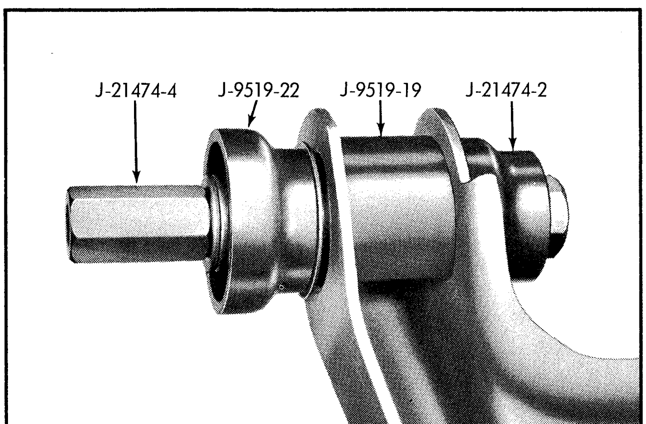


Fig. 3-21 Installing Bushing in Control Arm

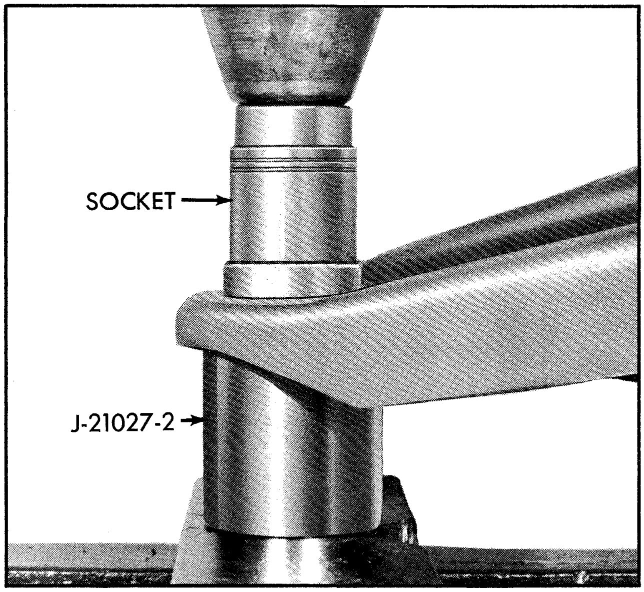


Fig. 3-22 Pressing Ball Joint from Lower Control Arm

***REPLACE***

1. Position new ball joint in lower control arm and start into place with tool J-5154.

*CAUTION: Ball joint rubber seal is not serviced. Removal or damage to seal necessitates replacement of complete ball joint assembly.*

2. Reassemble suspension. Tighten upper ball stud retaining nut to 55-70 lb. ft. torque. Tighten tie rod to steering arm nut to 30-45 lb. ft. torque. Tighten lower ball stud retaining nut to 85-100 lb. ft. torque.

3. Remove support under lower control arms and support at cross member.

4. Firmly seat ball joint in lower control arm (with aid of front spring pressure) using tool J-5154 and replace wheel.

***REMOVE AND REPLACE—CONTROL ARM OFF CAR***

1. Using suitable socket as driver and tool J-21027-2 as support press ball joint from control arm as shown in Fig. 3-22.

2. Install new ball joint by pressing into place using tool J-21027-2 support and installer J-8901 (Fig. 3-23).

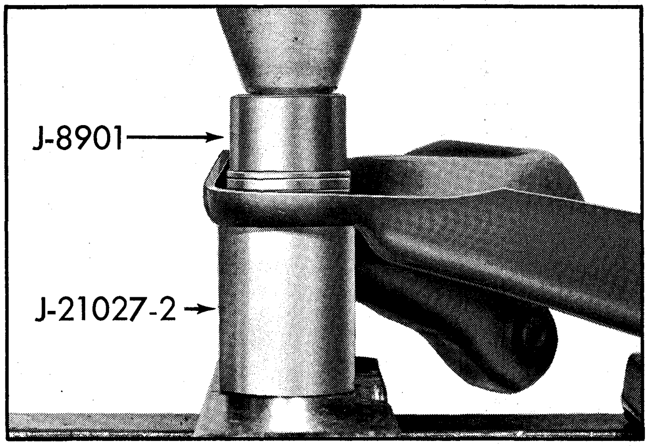



Fig. 3-23 Installing New Ball Joint in Lower Control Arm

*CAUTION: Ball joint rubber seal is not serviced. Removal or damage to seal necessitates replacement of complete ball joint assembly.*

### FRONT STABILIZER SHAFT—REMOVE AND REPLACE

1. Disconnect both links from stabilizer shaft by removing nut from link and rotating shaft up from lower control arm (Fig. 3-24).

2. Remove bolts holding two stabilizer shaft brackets to frame and remove shaft.

3. Attach stabilizer shaft to frame by placing two brackets over rubber insulators on bar and installing mounting bolts to frame. Tighten bolts to 10-15 lb. ft. torque. When properly installed the central portion of the shaft will be toward the front of car.

4. Place rubber grommet above and below lower control arm bracket and above and below eye of shaft with link spacer in between and insert link.

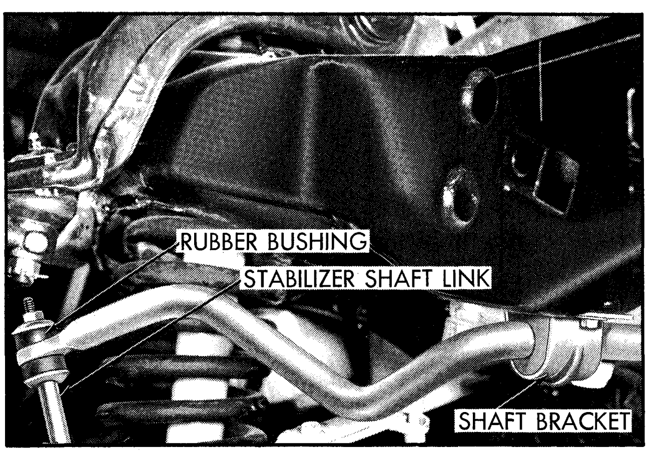



Fig. 3-24 Stabilizer Shaft Assembly

5. Install nut on each link, tightening to 60-120 lb. in. torque.

### REAR SHOCK ABSORBER—REMOVE AND REPLACE

1. Remove nuts, bolts and lock washers at upper end of shock absorber (Fig. 3-25).

2. Remove self-locking nut from lower end and remove shock absorber.

3. Clean and inspect rubber inserts. If inserts have shifted from their original position in either eye, discard old shock absorber and replace with new one.

4. Install shock absorber by reversing above steps.

5. Tighten lower self-locking nut 55-75 lb. ft. torque and upper bolt 15-25 lb. ft. torque.

### REAR SPRING
### REMOVE

1. Raise car until rear wheels are approximately 8" off floor.

2. Place safety stands under frame at both sides to support car.

3. Remove wheel assembly.

4. Disconnect brake line at cross member (Fig. 3-26).

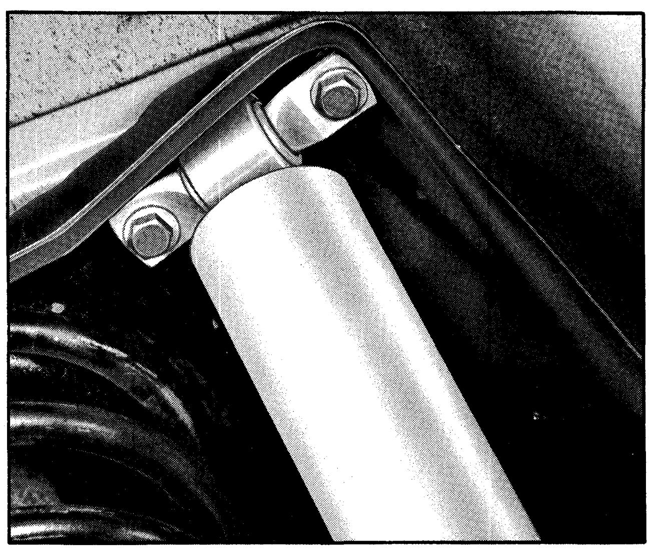


Fig. 3-25 Removal of Rear Shock Absorber

5. Remove self-locking nuts at lower end of right and left shock absorbers and disconnect shock absorbers from axle housing brackets.

6. Raise car as necessary and carefully lower rear axle assembly to allow spring to expand.

7. Remove nut, bolt, lock washer, flat washer and spring clamp at bottom of spring.

8. Remove spring (it may be necessary to force the axle down slightly to assist in removing the spring).

***REPLACE***

1. Place rubber insulator on top coil and position spring seat and rotate until seated.

2. Install lower clamp on spring and insert bolt, nut, lock washer and flat washer and tighten nut 30-40 lb. ft. torque (Fig. 3-27).

3. Raise rear axle assembly.

4. Attach both shock absorbers to axle housing brackets and tighten self-locking nuts 55-75 lb. ft. torque.

5. Attach brake tube bracket and line to cross member.

6. Install wheel assembly and bleed brakes.

***REAR UPPER CONTROL ARM—REMOVE AND REPLACE***

If both control arms are to be replaced, the axle may roll or slip sideways with both upper control arms removed making replacement difficult. Remove and replace one control arm at a time.

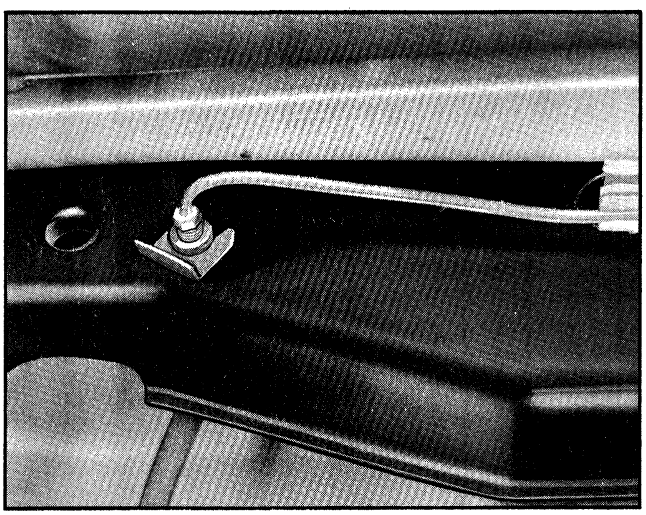


Fig. 3-26 Brake Tube and Line

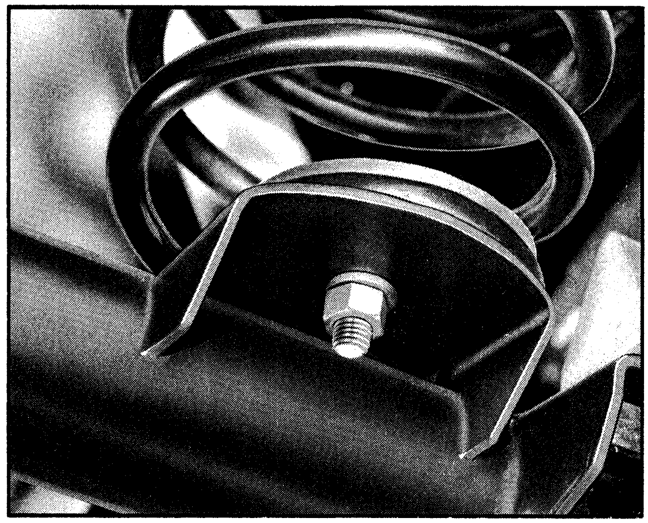


Fig. 3-27 Installing Spring Lower Clamp

1. Place car on hoist and raise rear end.

2. Remove bolt at rear axle housing and lift upper control arm to clear mounting bracket.

3. Disconnect rear upper control arm at frame cross member and remove upper arm assembly.

4. Clean and inspect rubber bushings and, if worn, replace.

5. Replace rear upper control arm by reversing above steps.

6. Tighten pivot bolts to 75-100 lb. ft. torque.

***REAR LOWER CONTROL ARM—REMOVE AND REPLACE***

If both control arms are to be replaced, the axle may roll or slip sideways with both lower control arms removed making replacement difficult. Remove and replace one control arm at a time.

1. Place car on hoist and raise rear end.

2. Remove bolt at rear end of rear lower control arm (below axle housing).

3. Remove bolt from front of rear lower control arm at frame and remove control arm assembly.

4. Clean and inspect rubber bushings and, if worn, replace.

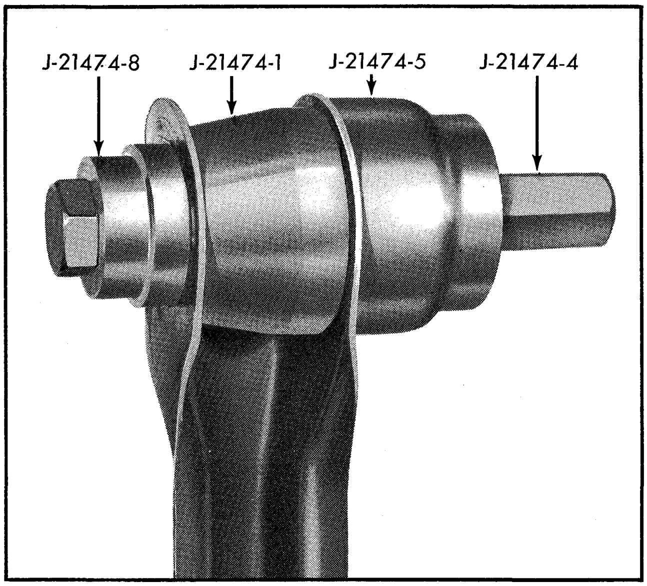



Fig. 3-28 Removing Bushing

5. Reverse above procedures for replacement of rear lower control arm. Tighten pivot bolts 75-100 lb. ft. torque.

*NOTE: Before tightening control arm pivot bolts, lower car to curb height.*

### REAR CONTROL ARM BUSHINGS (EXCEPT UPPER REAR BUSHING)—REMOVE AND REPLACE

1. Remove control arm from car as outlined above.

2. Support arm and remove bushing using tool J-21474 as shown in Fig. 3-28.

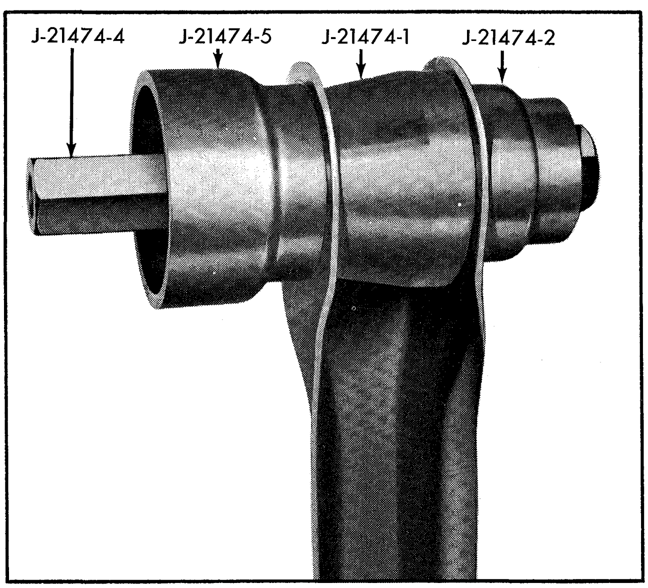



Fig. 3-29 Installing Bushing

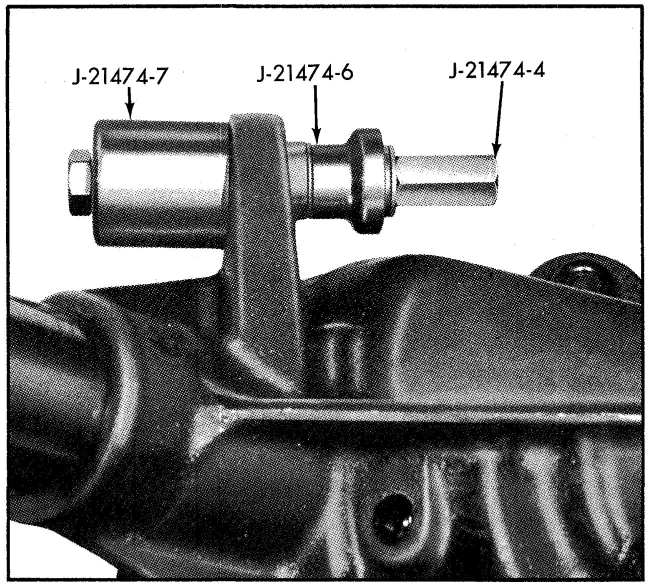



Fig. 3-30 Removing Rear Upper Control Arm Rear Bushing

3. Replace using components of tool J-21474 as shown in Fig. 3-29. Tighten pivot bolt to 75-100 lb. ft. torque.

### REAR UPPER CONTROL ARM REAR BUSHING—REMOVE AND REPLACE

1. Remove pivot bolt from control arm.

2. Remove bushing from axle housing using tool J-21474 as shown in Fig. 3-30.

3. Replace using components of tool J-21474 as shown in Fig. 3-31. Tighten pivot bolt to 75-100 lb. ft. torque.

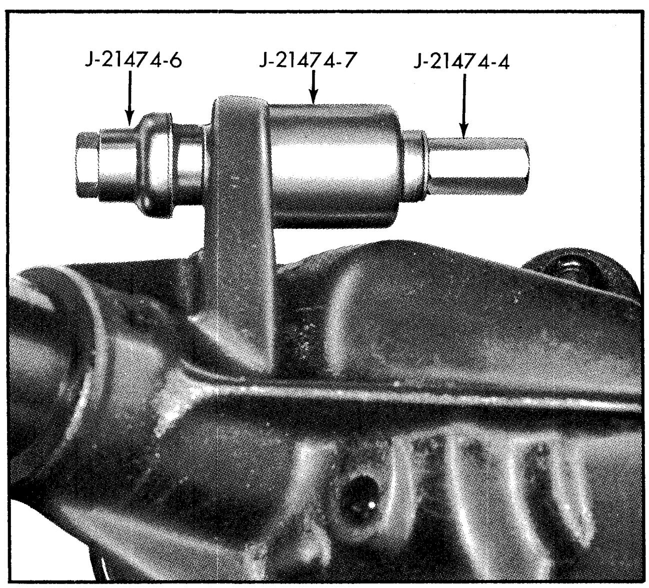



Fig. 3-31 Installing Rear Upper Control Arm Rear Bushing

## TROUBLE DIAGNOSIS AND TESTING

### HARD STEERING

| CAUSE | REMEDY |
|---|---|
| 1. Low or uneven tire pressure. | 1. Inflate tires to recommended pressure, section 3A. |
| 2. Steering gear or connections adjusted too tight. | 2. Test steering system for bind with front wheels off floor. Adjust, as necessary, and lubricate. |
| 3. Insufficient or incorrect lubricant used. | 3. Check lubricant in steering gear and lubricate steering system as required. |
| 4. Excessive caster. | 4. Check caster and adjust as necessary. |
| 5. Suspension arms bent or twisted. | 5. Check camber and caster. If arms are out of car, compare with new arms and replace if bent. |
| 6. Front spring sagged. | 6. Check front end jounce height. Jounce height should be approximately the same at both wheels. Compare dimensions with those on car having about same mileage and equipment and believed to be standard. Replace front springs if sagged. |
| 7. Frame bent or broken. | 7. Repair or replace frame as necessary. |
| 8. Steering knuckle bent. | 8. Install new knuckle. |
| 9. Ball joint galled or too tight. | 9. Replace ball joint. |
| 10. Ball joint grease seal deteriorated. | 10. Lubricate ball joints and steering linkage. |

### EXCESSIVE PLAY OR LOOSENESS IN STEERING

| CAUSE | REMEDY |
|---|---|
| 1. Steering gear or connections adjusted too loose or worn. | 1. Adjust or install new parts as necessary. |
| 2. Ball joints too loose. | 2. Install new ball joints. |
| 3. Front wheel bearings incorrectly adjusted or worn. | 3. Adjust or replace bearings as necessary. |

### ERRATIC STEERING ON APPLICATION OF BRAKES

| CAUSE | REMEDY |
|---|---|
| 1. Oil or brake fluid on brake lining. | 1. Replace lining and correct leak. |
| 2. Brakes incorrectly or unevenly adjusted. | 2. Adjust brakes. |
| 3. Front springs weak. | 3. Replace with new springs. |

### *ERRATIC STEERING ON APPLICATION OF BRAKES (Cont.)*

| CAUSE | REMEDY |
|---|---|
| 4. Low or uneven tire pressure. | 4. Inflate tires to recommended pressure. |
| 5. Incorrect or uneven caster or toe. | 5. Check and adjust caster and toe as necessary. |
| 6. Steering knuckle or control arms bent or pivot bushings badly worn. | 6. Replace with new parts. |
| 7. Front wheel bearings incorrectly adjusted. | 7. Adjust bearings as necessary. |

### *CAR PULLS TO ONE SIDE*

| CAUSE | REMEDY |
|---|---|
| 1. Low or uneven tire pressure. | 1. Inflate tires to recommended pressure. |
| 2. Incorrect or uneven caster or camber. | 2. Check caster and camber and correct by adjustment or by replacing worn or faulty parts. |
| 3. Wheel bearings adjusted too tight. | 3. Adjust wheel bearings. |
| 4. Front springs sagged. | 4. Check as outlined under HARD STEERING. |
| 5. Toe-in incorrect. | 5. Adjust toe-in as required. |
| 6. Oil or brake fluid on brake lining. | 6. Replace linings and correct leak. |
| 7. Brakes incorrectly or unevenly adjusted. | 7. Adjust brakes. |
| 8. Steering knuckle bent. | 8. Install new knuckle. |
| 9. Frame bent or broken. | 9. Check frame for proper alignment, and repair or replace frame as necessary. |
| 10. Shock absorber control weak. | 10. Check and replace shock absorbers if necessary. |
| 11. Rear wheels not tracking with front wheels. | 11. Check alignment of rear wheels with front wheels and correct as necessary. Check alignment of frame. |
| 12. Rear axle shifted. | 12. Check entire rear suspension. |

### *SCUFFED TIRES*

| CAUSE | REMEDY |
|---|---|
| 1. Tire improperly inflated. | 1. Inflate tires to recommended pressure. |
| 2. Toe-in incorrect. | 2. Adjust toe-in as required. |
| 3. Excessive wheel or tire runout. | 3. Check wheels and tires for wobble and proper mounting. |

***SCUFFED TIRES (Cont.)***

| CAUSE | REMEDY |
|---|---|
| 4. Ball joints too loose. | 4. Install new ball joints. |
| 5. Uneven camber. | 5. Check camber and adjust as necessary. |
| 6. Incorrect toe-out on turns. | 6. Install new steering knuckle arms. |
| 7. Arms bent or twisted. | 7. Check camber, ball joint inclination and caster. Replace arms with new ones if bent. |
| 8. Steering knuckle bent. | 8. Install new knuckle. |
| 9. Excessive speed on turns. | 9. Caution driver. |

***CUPPED TIRES***

| CAUSE | REMEDY |
|---|---|
| 1. Toe-in incorrect. | 1. Adjust toe-in as required. |
| 2. Tires improperly inflated. | 2. Inflate tires to recommended pressure. |
| 3. Worn ball joints, or wheel bearings incorrectly adjusted or worn. | 3. Adjust or replace parts as necessary. |
| 4. Uneven camber. | 4. Check camber and adjust as necessary. |
| 5. Steering knuckle bent. | 5. Install new knuckle. |
| 6. Excessive mileage without rotating tires. | 6. Rotate tires every 4000 miles. |

***FRONT WHEEL SHIMMY***

| CAUSE | REMEDY |
|---|---|
| 1. Low or uneven tire pressure. | 1. Inflate tires to recommended pressure. |
| 2. Wheels, tires or brake drums out of balance. (Near 70 mph) | 2. Balance wheels and tires. Also check for out-of-balance brake drums. |
| 3. Eccentric or bulged tires. | 3. Replace tires as necessary. |
| 4. Excessive wheel or tire runout. | 4. Check wheels and tires for wobble, radial runout, and proper mounting. |
| 5. Shock absorbers weak or no control. | 5. Check and replace shock absorbers if necessary. |
| 6. Steering linkage incorrectly adjusted or worn. | 6. Adjust or install new parts as necessary. |
| 7. Steering gear incorrectly adjusted. | 7. Adjust steering gear. |
| 8. Front wheel bearings incorrectly adjusted or worn. | 8. Adjust or replace bearings as necessary. |

### *FRONT WHEEL SHIMMY (Cont.)*

| CAUSE | REMEDY |
|---|---|
| 9. Incorrect or uneven caster. | 9. Check and adjust caster as necessary. |
| 10. Ball joints too loose. | 10. Install new ball joints. |
| 11. Toe-in incorrect. | 11. Adjust toe-in as required. |
| 12. Steering knuckle bent. | 12. Install new knuckles. |
| 13. Stabilizer shaft inoperative. | 13. Inspect bushings and links and replace worn parts. |

### *FRONT WHEEL TRAMP*

| CAUSE | REMEDY |
|---|---|
| 1. Wheels, tires or brake drums out of balance. (Near 70 mph) | 1. Balance wheels and tires. Also check for out-of-balance brake drums. |
| 2. Eccentric or bulged tires. | 2. Replace tires as necessary. |
| 3. Wheel or tire not concentric. | 3. Replace wheel or tires. |
| 4. Shock absorbers weak or no control. | 4. Install new shock absorbers. |
| 5. Stabilizer shaft inoperative. | 5. Inspect bushings and links and replace worn parts. |

### *CAR WANDERS*

| CAUSE | REMEDY |
|---|---|
| 1. Low or uneven tire pressure. | 1. Inflate tires to recommended pressure. |
| 2. Steering gear or connections adjusted too loose or worn. | 2. Adjust or install new parts as necessary. |
| 3. Steering gear or connections adjusted too tight. | 3. Test steering system for bind with front wheels off floor. Adjust as necessary and lubricate. |
| 4. Ball joints too loose. | 4. Install new ball joints. |
| 5. Toe-in incorrect. | 5. Adjust toe-in as required. |
| 6. Incorrect or uneven caster or camber. | 6. Check caster and camber and correct by adjustment or by replacing worn or faulty parts. |
| 7. Steering knuckle bent. | 7. Install new knuckle. |
| 8. Rear axle shifted. | 8. Check entire rear suspension. |
| 9. Stabilizer shaft inoperative. | 9. Inspect bushings and links and replace worn parts. |

***CAR WANDERS (Cont.)***

| CAUSE | REMEDY |
|---|---|
| 10. Ball joints too tight. | 10. Install new ball joints. |
| 11. Bind in upper or lower control arm shaft. | 11. Free up or replace parts. |
| 12. Excessive backlash in steering gear. | 12. Adjust steering gear. |

***ROAD SHOCKS***

| CAUSE | REMEDY |
|---|---|
| 1. High air pressure in tires. | 1. Bleed tires to recommended pressure but not when warm. |
| 2. Adjust steering gear and connections. | 2. Steering gear or connections incorrectly adjusted. |
| 3. Check caster and adjust as necessary. | 3. Excessive caster. |
| 4. Install new shock absorbers. | 4. Shock absorbers weak or no control. |
| 5. Check as outlined under HARD STEERING. | 5. Front springs sagged. |
| 6. Install new tires of correct type and size. | 6. Wrong type or size tires used. |
| 7. Install new knuckle. | 7. Steering knuckle bent. |

## SPECIFICATIONS

Caster angle (Exc. Sta. Wag.) . . . . $-1\text{-}1/2° \pm 1/2°$

Caster angle (Sta. Wag.) . . . . . . . . . $-2° \pm 1/2°$

Camber angle . . . . . . . . . . . . . . $+1/4° \pm 1/2°$

*NOTE: Give left wheel up to 1/4° maximum more than right wheel to correct for road crown.*

Toe-in . . . . . . . . . . . . . . . . . . . . 0" to 1/8"
(with trammel 9" above floor) Set to 1/16".

Toe-out on turns . . . . . . . . . . . . . . . . . . 1°
(difference in left to right in direction of toe-out at 20° turning of inside wheel)

*NOTE: Adjust for caster, camber and toe-in with car at curb load. Compensate for drift to right due to road camber by setting left camber angle 1/4° greater than right. See CAMBER ADJUSTMENT PROCEDURE.*

## TORQUE SPECIFICATIONS

**Torque in lb. ft. unless otherwise specified.**

| APPLICATION | TORQUE |
|---|---|
| **Front Suspension** | |
| Bolt - Upper Control Arm Pivot Shaft | 35-45 |
| Nut - Upper Control Arm Shaft to Upper Control Arm Frame Bracket | 55-75 |
| Bolt - Lower Control Arm Assy. | 75-100 |
| Nut - Lower Control Arm Frame Bumper to Arm | 10-20 |
| Nut - Steering Knuckle to Ball Stud Assembly - Upper | 55-70 |
| Nut - Steering Knuckle to Ball Stud Assembly - Lower | 85-100 |

## TORQUE SPECIFICATIONS (Cont.)

### Front Wheels, Hubs and Bearings

| | |
|---|---|
| Nut - Wheel to Hub - R.H. and L.H. | 70-85 |

### Front Shock Absorbers

| | |
|---|---|
| Nut - Shock Absorber to Frame | 60-120 lb. in. |
| Bolt - Shock Absorber to Lower Arm | 15-25 |

### Front Stabilizer

| | |
|---|---|
| Bolt - Stabilizer Shaft Bracket to Frame | 10-15 |
| Nut - Stabilizer Link | 60-120 lb. in. |

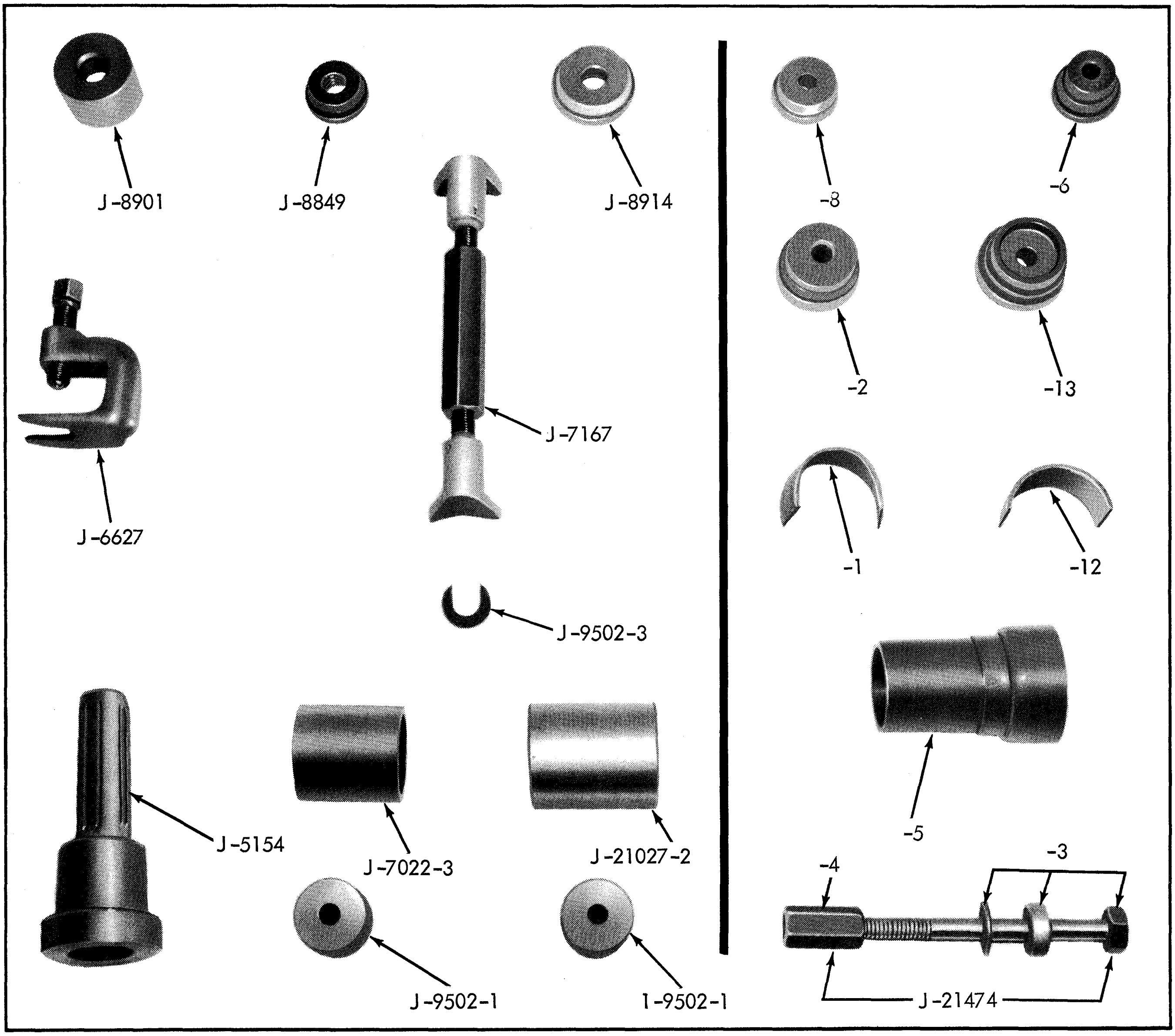
### Rear Spring Installation Parts

| | |
|---|---|
| Bolt - Upper Control Arm Assy. to Axle Hsg. | 75-100 |
| Bolt - Lower Control Arm Assy. to Axle Hsg. | 75-100 |
| Bolt - Lower Control Arm Assy. to Frame | 75-100 |
| Bolt - Upper Control Arm Assy. to Frame | 75-100 |
| Bolt and Nut - Axle Bumper to Frame | 40-55 |
| Bolt and Nut - Spring Lower Clamp to Axle Hsg. Seat | 30-40 |

### Rear Shock Absorbers

| | |
|---|---|
| Bolt - Shock Absorber Upper | 15-25 |
| Nut - Shock Absorber Lower | 55-75 |

# SPECIAL TOOLS




| | |
|---|---|
| J-8901 | Installer |
| J-8849 | Installer |
| J-8914 | Installer |
| J-6627 | Puller |
| J-7167 | Spreader |
| J-9502-3 | Spacer |
| J-5154 | Installer |
| J-7022-3 | Support |
| J-21027-2 | Support |
| J-9502-1 | Installer |
| J-21474-1 | Spacer |
| J-21474-2 | Installer, Remover |
| J-21474-3 | Screw Assembly |
| J-21474-4 | Nut |
| J-21474-5 | Receiver |
| J-21474-6 | Remover, Installer |
| J-21474-8 | Remover |
| J-21474-12 | Spacer |
| J-21474-13 | Installer |

Fig. 3-32 Special Tools

# WHEELS AND TIRES

## CONTENTS OF THIS SECTION



## GENERAL DESCRIPTION

Drop center rim steel wheels secured by right hand thread nuts on both sides of car are used on all models. The rim width is 5.0" and wheel diameter 14". Low pressure 6.50 x 14 4 ply rating tires are standard equipment on all models except station wagons and V-8 engine option. Station wagons and cars having V-8 engine option are equipped with 7.00 x 14 (with optional 7.50 x 14) 4 ply rating tires. All tires are of tubeless construction.

| Tire Size | Starting Pressure (After Car Has Been Standing For Three Hours) | City Pressure (After Driving Car Three Miles or More Below 40 MPH) | Highway Pressure (After Driving Car Three Miles or More Above 40 MPH) |
|---|---|---|---|
| 6.50 x 14 - 4 Ply Rating | | | |
| All | | | |
| Front | 24 | 26 | 28 |
| Rear | 22 | 24 | 26 |
| 7.00 x 14 - 4 Ply Rating | | | |
| All Exc. Wagon | | | |
| Front | 24 | 26 | 28 |
| Rear | 22 | 24 | 26 |
| 7.00 x 14 - 4 Ply Rating | | | |
| Wagon | | | |
| Front | 24 | 26 | 28 |
| Rear | 26 | 28 | 30 |
| 7.50 x 14 - 4 Ply Rating | | | |
| All Exc. Wagon | | | |
| Front | 24 | 26 | 28 |
| Rear | 22 | 24 | 26 |
| 7.50 x 14 - 4 Ply Rating | | | |
| Wagon | | | |
| Front | 22 | 24 | 26 |
| Rear | 26 | 28 | 30 |

*NOTE: It is normal for air pressure to build up in a tire due to driving conditions; therefore, do not let air out of tires to reduce this increase in pressure.*

Fig. 3A-1 Tire Pressure Chart

## PERIODIC SERVICE

### *INFLATION OF TIRES:*

Maintenance of correct inflation pressure is one of the most important elements of tire care. The inflation pressure recommended for any model of car is carefully worked out as the best pressure to give a correct balance of those factors in good car performance which are affected by inflation pressure. Some of these factors are: satisfactory ride, stability, steering, tread wear, cord life and resistance to stone bruises.

Tire pressure, with tires cold, should be checked once a month. Pressure should be changed if necessary, to conform to specifications on chart (Fig. 3A-1). It is normal for air pressure in tires to increase as temperature of tires increase due to car being driven.

When it is not possible to check air pressure when tire is cold, it may be checked with tires warm using pressure recommended for city and highway driving given in specifications. It must be recognized that this method is not as accurate as checking pressure when tires are cold. One driver's tires may get warmer than another driver due to difference in speed, acceleration and braking.

NOTE: *Always check tires with accurate gauge.*

Tire valve caps should always be reinstalled on the valve and tightened finger tight. They assist in keeping air in the tire in case of a valve leak, and keep dust and water out of the valve.

Higher than recommended inflation pressure will give:

1. A harder riding car.

2. A tire carcass more susceptible to bruising or carcass damage directly under the tread.

3. Poorer traction at rear wheels resulting in uneven wear.

4. Fast tread wear at center of tire.

Lower inflation pressures than recommended will give:

1. Increased tire squeal on turns.

2. Harder steering.

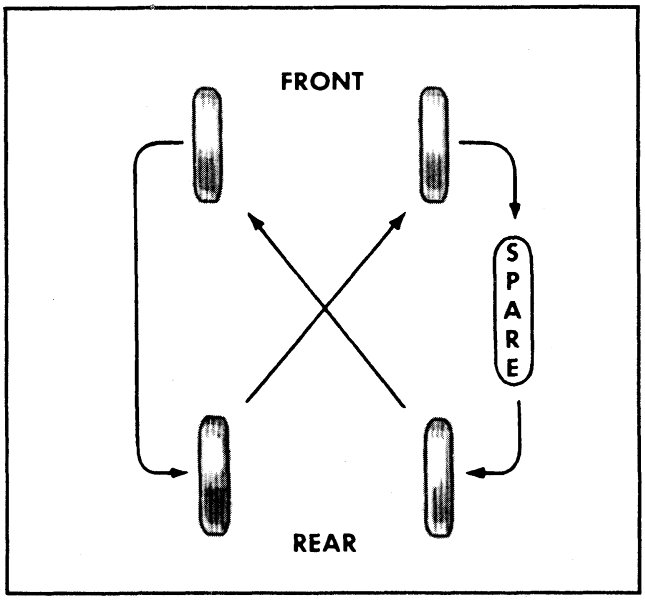



Fig. 3A-2 Diagram for Switching Tires

3. Rapid and uneven wear on the edges of tire tread.

4. A tire more susceptible to rim bruises and various types of rupture.

5. Increased cord fatigue or broken tire cords.

6. Increased tramp and shimmy troubles.

7. Higher tire temperatures.

8. Increased car roll when turning a corner or making a sharp swerve in traffic.

### *TIRE ROTATION:*

Uneven tire wear is frequently the cause of tire noises which are attributed to rear axle gears, bearings, wheels, etc., and at times unnecessary work has been done on rear axle assemblies in an endeavor to correct this noise.

To minimize the possibility of tire noise and equalize wear, it is recommended that tires be rotated as shown in Fig. 3A-2, approximately each 6,000 miles. They should be rotated more frequently when tires are subjected to extremely hard use. This will prevent undue wear on any particular tire which might cause excessive noise. More important from the owner's viewpoint, will be equalization of wear on all tires and the saving made through getting some use from the spare tire which all too often is allowed to remain as a spare until the other tires are worn

out. When this occurs, the spare tire, while appearing to be new will actually have deteriorated through disuse. If the rotating of tires if followed each 6,000 miles in accordance with Fig. 3A-2, all tires will have had the same number of miles in each wheel position at the end of the fourth change or when ready to interchange tires for the fifth time. The car will have been driven 80,000 miles, but each tire will have only 24,000 miles of use.

*CAUTION: Hub caps are made of brass and care should be used not to damage them when removing or installing them.*

Each time tires are switched they should be inspected for signs of abnormal wear, bulging, etc. and all stones, nails, glass, etc., removed before reinstalling tire and wheel on car.

## MINOR REPAIRS

### TEST FOR LEAKS:

1. Use soapy water to check valve for leaks. In many cases air loss can be corrected by simply tightening the valve core.

2. If the reason for air loss is not immediately discernible, submerge the complete wheel assembly in a tank of water.

3. Mark the tire and rim at the point where air is escaping.

Tire Mounting and Dismounting Instructions:

The wheel assembly has a flat hump bead seat on the outboard (valve hole) side of rim (Fig. 3A-3). This design provides a tight tire fit making it necessary to use a rubber lubricant or a vegetable oil soap solution for tire mounting and dismounting. This design also make it mandatory that tire mounting and dismounting are done with the inboard side of the wheel up.

### WHEEL STUD

### REMOVE & REPLACE

1. Press the damaged stud out or carefully drive out with hammer.

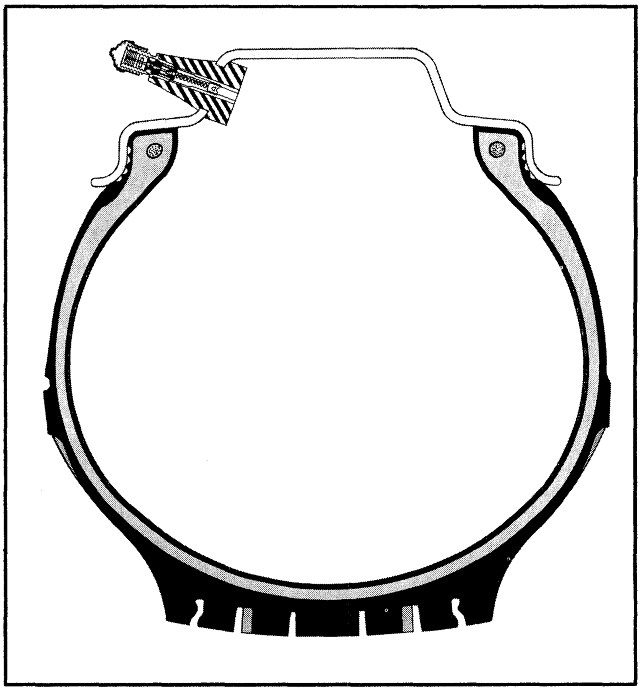


Fig. 3A-3 Cross Section of Typical Tubeless Tire

2. Insert the new stud taking utmost care to realign the serrations of the stud with the serrations in the drum.

*CAUTION: Proper serration alignment is necessary to avoid distortion and breaking out of metal around the machined flat surface that contacts the wheel rim lugs.*

3. Using a wheel nut and several large flat washers, pull the stud into place by tightening the nut.

### REMOVE TIRE FROM WHEEL:

1. Remove valve cap and valve core. Let out all the air.

2. With valve hole side of tire down, break beads away from rim. Use only conventional bead-breaker type machine.

*CAUTION: Do not use hammer or tire irons.*

3. Apply a liberal amount of rubber lubricant or thin vegetable oil soap solution to both beads and remove the first bead, using the machine method.

*CAUTION: During the entire operation of breaking beads away from rim and removing tire from rim,*

*special care should be taken not to damage the sealing ridges along the tire beads.*

#### PUNCTURE REPAIRS:

Puncture repairs may be quickly and permanently performed using one of several kits available through tire manufacturer's dealer outlets.

#### WHEEL LEAKS:

Examine rim flanges for sharp dents. Any dent visible to the eye should be straightened.

*CAUTION: Under no circumstance should wheels be brazed, welded or peened.*

#### PREPARATION OF TIRE:

Remove excess "strings" of rubber hanging from tire bead.

#### PREPARATION OF RIM:

1. Clean the rim flanges using a small piece of No. 3 coarse steel wool or emery cloth removing all oxidized rubber, soap solution, rust, etc. If rim is badly pitted a file can be used.

2. Straighten or replace rim if it is bent or damaged.

#### MOUNTING TIRE ON WHEEL:

1. Install valve if valve was removed. Always install valve recommended by car manufacturer.

2. Apply liberal amounts of vegetable oil soap solution or approved rubber lubricant to rim edges and tire beads.

3. Mount the tire on the wheel with valve hole side down using the machine method.

4. Remove valve core from stem to increase flow of air.

5. With casing on the rim so that the beads are resting uniformly on the bead ledge and quickly apply a large volume of air. This forces the bead on the bead seat and against the flanges where the air seal for the tire is obtained. Inflate tire until beads are completely forced against rim flanges.

*CAUTION: Do not stand over tire when inflating. Bead wire may brake when bead snaps over safety bump. Do not exceed 40 lb. air pressure when inflating. If 40 lbs. pressure will not seat beads properly, deflate, lubricate, and reinflate.*

6. Once the beads are seated against the rim flanges, the air pressure can be released.

7. Install valve core and inflate to proper specifications.

8. General precautions in mounting tires:

   a. Use tire mounting and dismounting machine.

   b. Do not use hammer or tire irons.

   c. Work over rim flange so that the section nearest the valve stem will be applied last.

#### TIRE BALANCING

Factory specifications call for wheel and tire assemblies to be in balance within 6 inch ounces maximum. Under certain circumstances it may be necessary to use weights greater than maximum to obtain satisfactory balance. When greater than 3 ounces of weight are used, split weights between inside and outside of rim. Use heavier weight on the inside if weights added are not equal. When total weights used exceed 6 ounces, this is an indication of a bad tire.

Wheels on new cars are statically balanced at the factory to less than 6 oz. which is well within requirements for smooth operation on the car.

Shimmy or tramp may be caused by radial runout or eccentricity of the tire and/or wheel assembly as well as out of balance. Radial runout may be caused by a variation in tire tread surface caused by skidding, a damaged tire, a bent or distorted wheel, or an improperly mounted tire.

*NOTE: Shimmy is always aggravated by worn front tires. When shimmy is a problem, use best tires on front of car.*

All four tires and wheels should be checked for radial runout at the points indicated on the diagram, see Figs. 3A-4 and 3A-5.

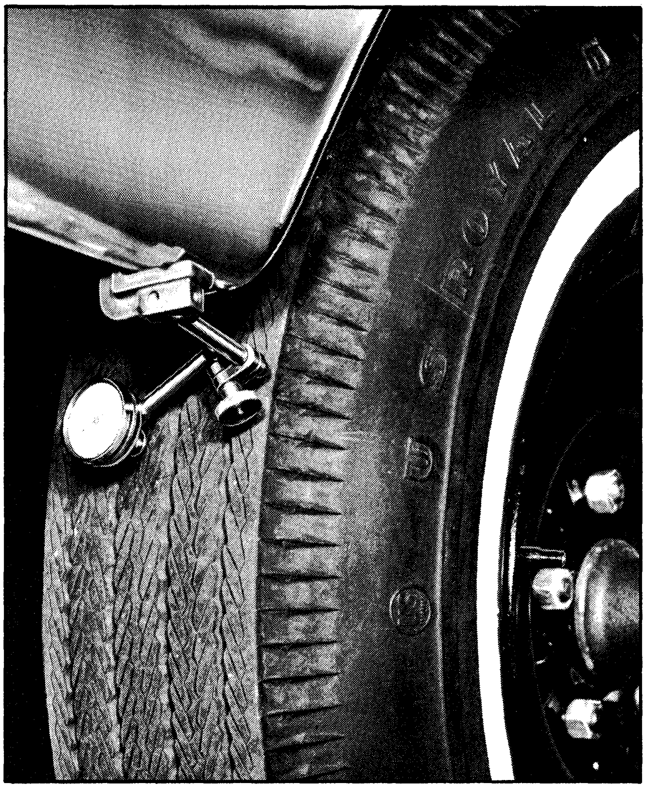


Fig. 3A-4 Mounting Dial Indicator

*NOTE: Wheels and tires are beyond tolerance and should be replaced before proceeding if runout exceeds the following Wheel radial runout .035" or wheel and tire assembly radial runout .050".*

Lateral runout of each front wheel and tire may be checked by placing a dial indicator against either of the tire buff ribs. Make the check on the inside buff rib if the outside is worn or distorted due to hard curbing.

The maximum allowable lateral runout of each front wheel and tire is 1/8". The following corrective steps are taken if this is not obtainable.

1. Rotate tire on wheel.

2. Make wheel and tire runout check.

3. Make wheel runout check if lateral wheel and tire runout exceeds 1/8" after tire rotation.

4. Excessive runout is in wheel if runout obtained in step 3 is greater than 1/8", and in tire if runout obtained in step 3 is less than 1/8".

Balance all tire and wheel assemblies on the car with tires at normal operating temperature as follows:

1. Spin assembly with balancer spinner to locate heaviest point. Mark point with chalk.

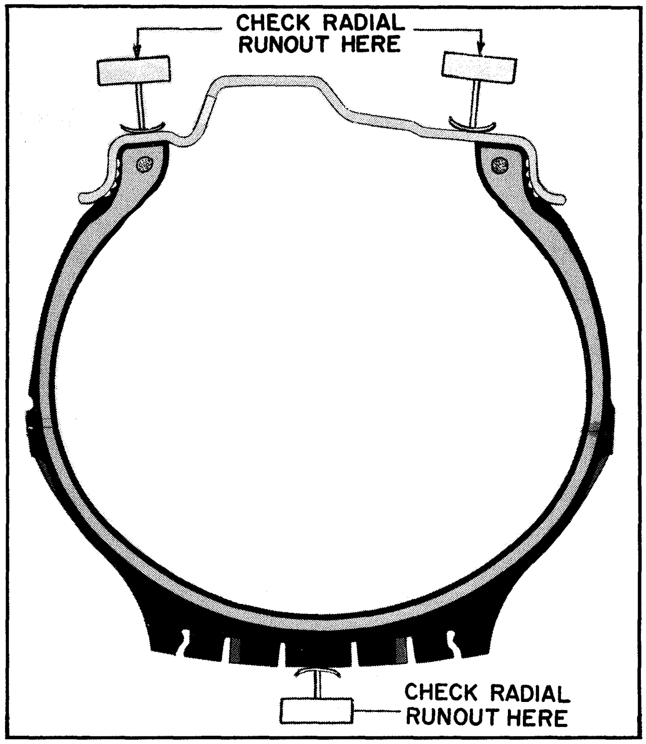



Fig. 3A-5 Checking Radial Runout

2. Remove wheel and tire assembly and rotate on drum until heaviest point of the assembly indexes with lightest point on the drum (the weight on the outer rim of the drum face marks the lightest point on the drums are balanced light at manufacture, see Fig. 3A-6.

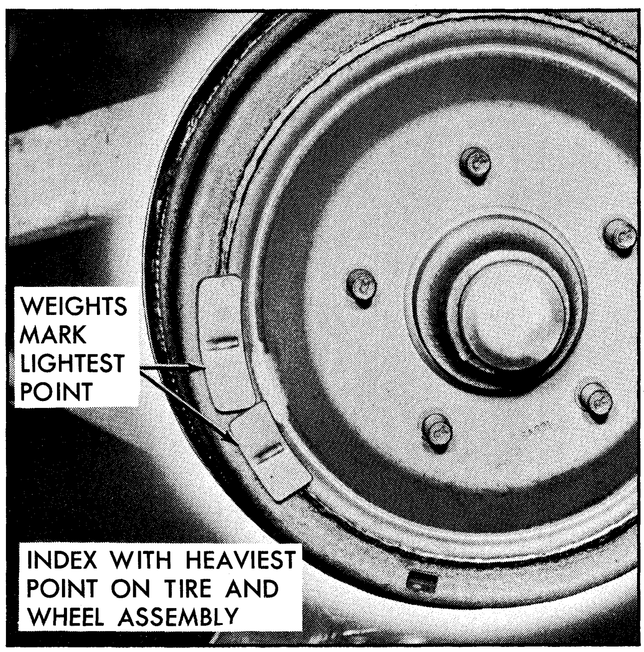



Fig. 3A-6 Indexing Drum

3. Proceed to balance tire and wheel assembly in manner recommended by manufacturer of equipment being used.

*NOTE: Amount of weights needed to compensate for static unbalance should be evenly divided and half added to inside of rim and half outside. This will eliminate the necessity of adding weights during dynamic balance to compensate for weights added during static balance.*

## TROUBLE DIAGNOSIS AND TESTING

### TIRE INSPECTION

Upon careful inspection of tires, it may be found that improper wheel alignment, grabbing brakes, poor driving habits, fast cornering or other conditions are the cause of wear, such conditions should be corrected. Listed below are common types of irregular tire wear and possible causes.

### UNDERINFLATION

The result of underinflation is shown (Fig. 3A-6). Car weight distorts the normal contour of the tire body and the tire bulges or "bellies out" with an extreme flexing action. This wears the tread at the edges more than the center and generates excessive internal heat weakening the cords and resulting in bruises, broken cords or ply separation. Underinflation also leads to rim bruises as insufficient resistance is provided to prevent the tire from being jammed against the rim and crushed or cut when the tire strikes a curb, rock, or rut.

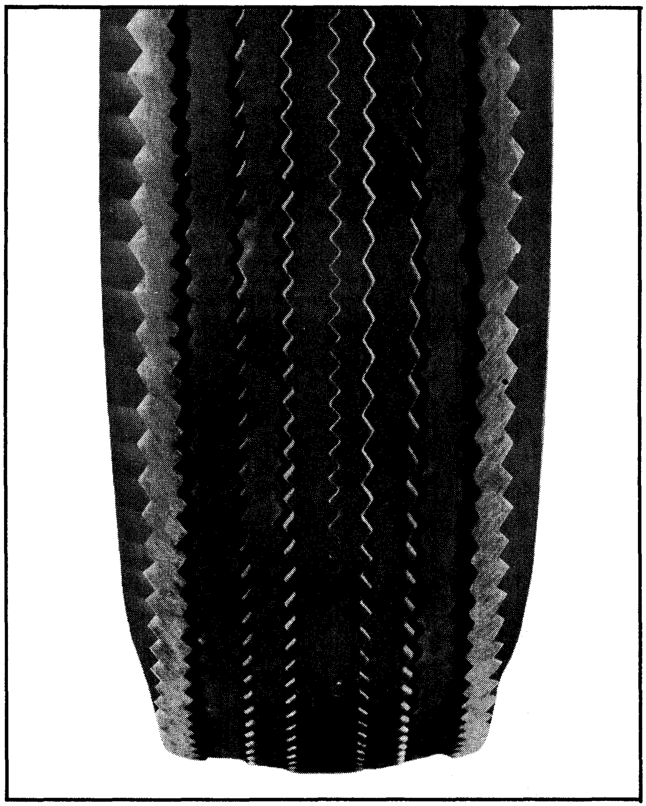


Fig. 3A-7 Wear from Underinflation

### OVERINFLATION

The result of overinflation is shown in Fig. 3A-7. When a tire is overinflated, increased tension caused by excessive pressure prevents proper deflection of the sidewalls. This results in wear in the center of the tread and the tire also loses its ability to absorb road shocks. Under this increased strain, cords in the tread area eventually snap under impact, causing either a characteristic X-break or diagonal break.

### SIDE WEAR (CAMBERING OR CORNERING WEAR):

There are three reasons why tires wear more rapidly on one side of the tread than on the other.

1. Wheel camber causes the tires to run at a certain angle from the perpendicular, resulting in side wear.

2. Side thrust when rounding turns causes wear on the sides of front tire treads. In making a turn to the left, especially at high speeds, the outside shoulder of the right tire and the inside shoulder of the left tire take most of the wear. When making a right hand turn, the opposite shoulders of the tires are worn.

3. High crowned roads cause increased wear on the side of the right front tire. This is particularly true when there is too much toe-in on front wheels or when positive camber of right front wheel is greater than the left.

Cornering wear can usually be differentiated from camber wear because cornering wear affects both sides of the tire giving it a very round appearance (Fig. 3A-8). When camber is incorrect it will cause excessive wear only on one side of the tire tread. Camber wear does not leave the tread rounded as cornering wear does.

When cornering wear is encountered, the owner should be shown, by the rough tire surface and

rounded shoulders, that he is severely abrading his tires by fast or sharp turns, and told that he could greatly prolong the useful life of his tires by taking the turns a little slower. The tires and wheels should be switched (Fig. 3A-2) and continued in service the same as with normal camber wear.

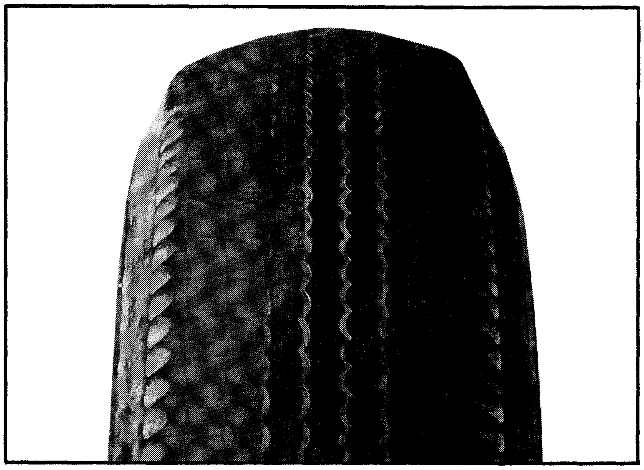


Fig. 3A-9 Cornering Wear

### TOE-IN OR TOE-OUT MISALIGNMENT WEAR

Front wheels should be straight ahead or toe-in slightly. When there is excessive toe-in or toe-out, tires will revolve with a side motion and scrape the tread rubber off. Front tires will show wear on the outside with a toe-in condition and on the inside with a toe-out condition. The above wear pattern is reversed when considering toe relative to rear tires. Fig. 3A-9 illustrates the wear pattern due to improper toe.

### UNEVEN TIRE WEAR

Other types of uneven tread wear such as a single spot or series of cuppings around the tire circumference (Fig. 3A-10) may also be noted on some tires. Such uneven wear may be due to excess toe-in or toe-out with underinflation, uneven camber, or such irregularities as bent or worn suspension, wobbly wheels, improper caster, out of round brake drums, and unequally adjusted brakes.

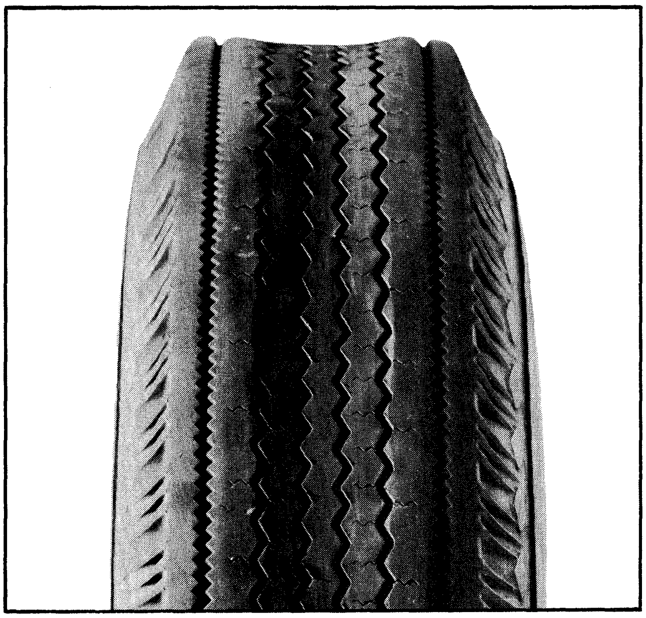


Fig. 3A-8 Wear from Overinflation

### TREAD WEAR

Tread wear is affected by wheel alignment, cornering, inflation pressure, etc., as mentioned previously. There are several factors which must be considered in analyzing tread wear.

A careful driver may obtain many times the mileage from his tires as would be obtained by a severe driver. Also, tires wear much faster in some localities depending on the type of road (some are more abrasive than others), condition of road (rain or snow), the number of sharp turns, hills or mountains the car must go up or down, and the prevailing

Fig. 3A-10 Toe-in or Toe-out Misalignment Wear

temperature. Fast driving, quick starting, and hard stopping are generally recognized as a definite cause of rapid tread wear. Temperature is often not considered to be as great a factor in tire life as it actually is. By actual test an increase of 40°F in temperature reduces tread mileage by 33%.

### TESTING FOR TIRE NOISES

To determine whether tires are causing the noise complained of, use the following procedure:

Check car to see if it is equipped with snow tires. These tires produce a noise which the owner will have to ignore or overlook. If not equipped with snow tires, drive the car at various speeds and note the effect of acceleration and decleration on noise. Axle and exhaust noise show definite variations under these conditions while tire noise will remain constant. Tire noise generally is most pronounced on smooth black top roads at speeds between 15 and 40 miles per hour.

Tire thump is the periodic noise with each revolution of the wheel. It is prominent only on smooth black top pavement that is free of surface irregularities. Tire thump may be checked by driving the car over a smooth black top pavement with tires at recommended inflation pressure, and again over the same stretch of road with the tires inflated to 50 lbs. and dropping the pressure in one tire at a time to normal.

*CAUTION: Be careful not to strike any obstructions or rocks in road with tire at 50 lbs. pressure as this will lead to a rupture in the casing. Operate car with higher than recommended inflation only while testing. Do not operate car over 50 MPH with high tire pressure.*

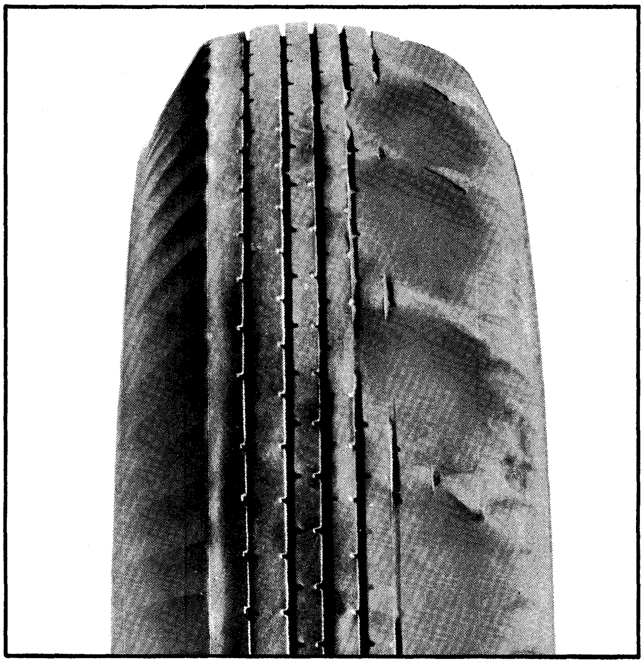


Fig. 3A-11 Spot Wear

Carefully inspect the tire making the noise for bulges, irregular wear, low air pressure, toe and heel (saw tooth) wear, and unusual tread design (ribbed tread gives less noise than some all weather treads; mud and snow treads are very noisy). Checking wheel alignment and rotating tires will usually cure tire noises unless caused by tire tread design, heavy irregular tread wear, or tire bulges.

## SPECIFICATIONS

### WHEELS

| | |
|---|---|
| Material | Steel |
| Type | Drop Center—with flat safety hump. |
| Diameter | 14" |
| Width | 5.0" |

### TIRES

| | |
|---|---|
| All Exc. Sta. Wag. and V-8 | 6.50 x 14 |
| Sta. Wag. and V-8 | 7.00 x 14 |
| Oversize for Sta. Wag. and V-8 | 7.50 x 14 |
| Type | Tubeless |
| Ply Rating | 4 |

## TORQUE SPECIFICATIONS

| | LB. FT. |
|---|---|
| Wheel to Drum Nut—Front and Rear | 70-85 |

# REAR AXLE

## CONTENTS OF THIS SECTION



# STANDARD DIFFERENTIAL

## GENERAL DESCRIPTION

The rear axle assembly is of modified Hotchkiss drive construction utilizing a hypoid ring gear and pinion set as a means of transmitting power (torque) from the propeller shaft through a differential and then to semi-floating axle shafts.

Two rear axle upper control arms and two lower control arms (Fig. 4-1), with rubber bushings at connecting pivot points, form the basic links of rear suspension. The functions of the lower control arms are to maintain the axle in line relative to frame and to oppose torque reaction of the rear axle. The upper control arms control rear axle "windup" and maintain lateral stability of the car on the axle.

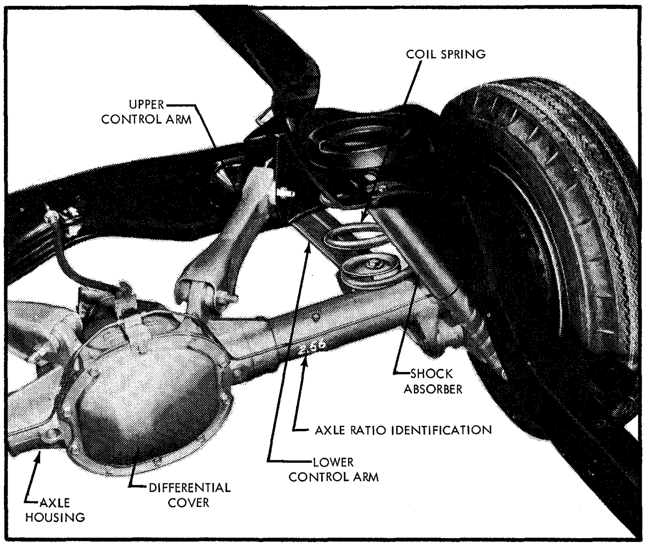



Fig. 4-1 Rear Axle Parts

The upper ends of rear coil springs are retained in seats formed in the frame while the lower ends ride on spring pads welded to the housing just forward of the center line of axle assembly.

Direct-acting sealed shock absorbers are mounted with upper ends inclined toward center of vehicle. Rubber bumpers, attached to the frame above the rear axle, cushion extreme downward movement of the frame and body.

All parts necessary to transmit power from the propeller shaft to the rear wheels are enclosed in a salisbury type axle housing. It is an iron casting with tubular axle housings pressed and welded into the carrier to form a complete carrier and tubes assembly. It is characterized by a removable, steel cover, bolted to the rear of the carrier which permits service of the differential without removing the rear axle from the car. Rear axle shafts are mounted on heavy duty ball bearings located at the outer ends of the rear axle housing. Each bearing is pressed to a shoulder on the shaft and is additionally held in place by a pressed-on inner retainer ring. An outer retainer, which also clamps the brake backing plate to the axle housing, secures the bearing in the end of the axle housing. Axle shaft bearings are pre-lubricated and are backed by oil seals (pressed into the outer ends of the axle housing)

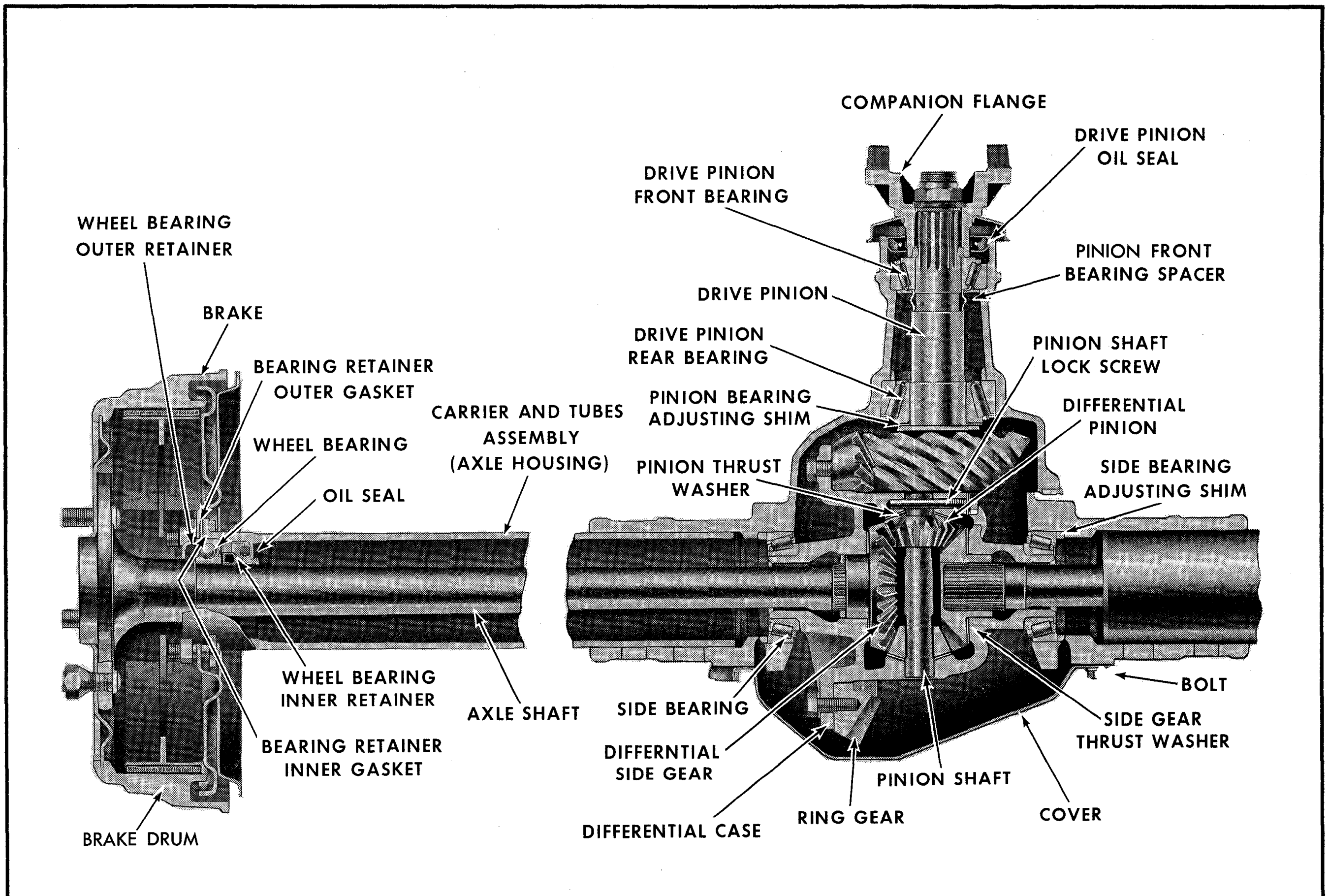



Fig. 4-2 Cross Section - Rear Axle

which prevent oil seepage from the axle housing into the wheel bearing cavity and onto the brake assembly.

A breather vent with cap, to prevent entrance of dirt and water, is provided at the right side of the axle housing.

### DESIGN

Hotchkiss drive is the basic design used to transmit power from the drive shaft to the rear wheels but design is modified by torque reaction links (upper and lower control arms) rather than leaf springs. A universal joint connects the end of the propeller shaft to a companion flange having a splined end which fits over, and drives, the rear axle drive pinion gear. This companion flange is securely fastened to the pinion shaft by a special self-locking nut which bears against a special washer.

Two preloaded taper roller bearings support the drive pinion gear in the carrier. The inner race of the rear bearing is a tight press-fit on the pinion stem. The inner race of the front bearing combines a light press-fit to a close sliding fit on the companion flange end of the pinion stem. The outer race of each bearing is pressed against a shoulder recessed in the carrier. Tightening the pinion nut compresses a collapsible spacer (Fig. 4-2), which bears against the inner race of the front bearing and a shoulder on the pinion stem. This spacer is used to maintain a load on the front bearing inner race and the pinion stem and to prevent the inner race of the front bearing from turning on the pinion stem.

Adjustment of the pinion along its axis is obtained by placing shims between the pinion rear bearing inner race and the pinion gear. Torque from the pinion gear is transmitted to a ring gear attached to a differential case by ten special hex head bolts.

The differential is a devise that divides the torque between axle shafts. It permits the rear wheels to turn together, at the same speed, or to turn at different speeds; as when making turns, etc.

The standard or conventional differential divides torque and the rear wheels equally and is so designed that it will exert no more propelling effort than can be applied to the wheel having the least traction. The differential case is of one piece construction. Four small gears are housed within the case; two side gears and two pinion gears. The two side gears have splined bores for indexing with and driving each of the axle shafts and are positioned to turn in counterbored cavities in the case. The two differential pinion gears have smooth bores and are held in position by a solid pinion cross shaft mounted and locked in the differential case. All four gears are in mesh with each other and, because the pinion gears turn freely on their shaft, they act as idler gears when rear wheels are turning at different speeds.

### OPERATION—STANDARD DIFFERENTIAL

Power from the engine is transmitted to the transmission via a clutch or, in the case of a Auto-Matic transmission, a fluid coupling. The transmission then provides the transfer of power to its output shaft which is splined to the propeller shaft by means of a universal joint connection. Since the rear of the propeller shaft is connected to the differential pinion gear at the companion flange, the transmission output shaft, propeller shaft and the differential pinion all turn at the same speed.

Power from the pinion gear is transmitted to the differential ring gear which is bolted to the differential case. When there is equal resistance on each rear wheel, the force through the pinion and ring gear turns the axle shafts at the same rate of speed. Since the same amount of power is being transmitted to each wheel, the differential gears are "locked" together and there will be no rolling of the differential pinion gear teeth over the differential side gear teeth (the two pinion gears are secured inside the differential case by a pinion shaft locked to the case).

When the vehicle turns a corner, the outer rear wheel must turn faster than the inner one. The inner wheel, turning slower with respect to the outer wheel, slows up the differential side gear (as the axle shaft is splined to the side gear) and the differential pinion gear will roll over the slowed up differential side gear driving the other differential side gear and wheel faster.

The differential allows both wheels to be mounted on individual axles and driven by single shaft, yet it permits each wheel to move independently and at different speeds when the need arises.

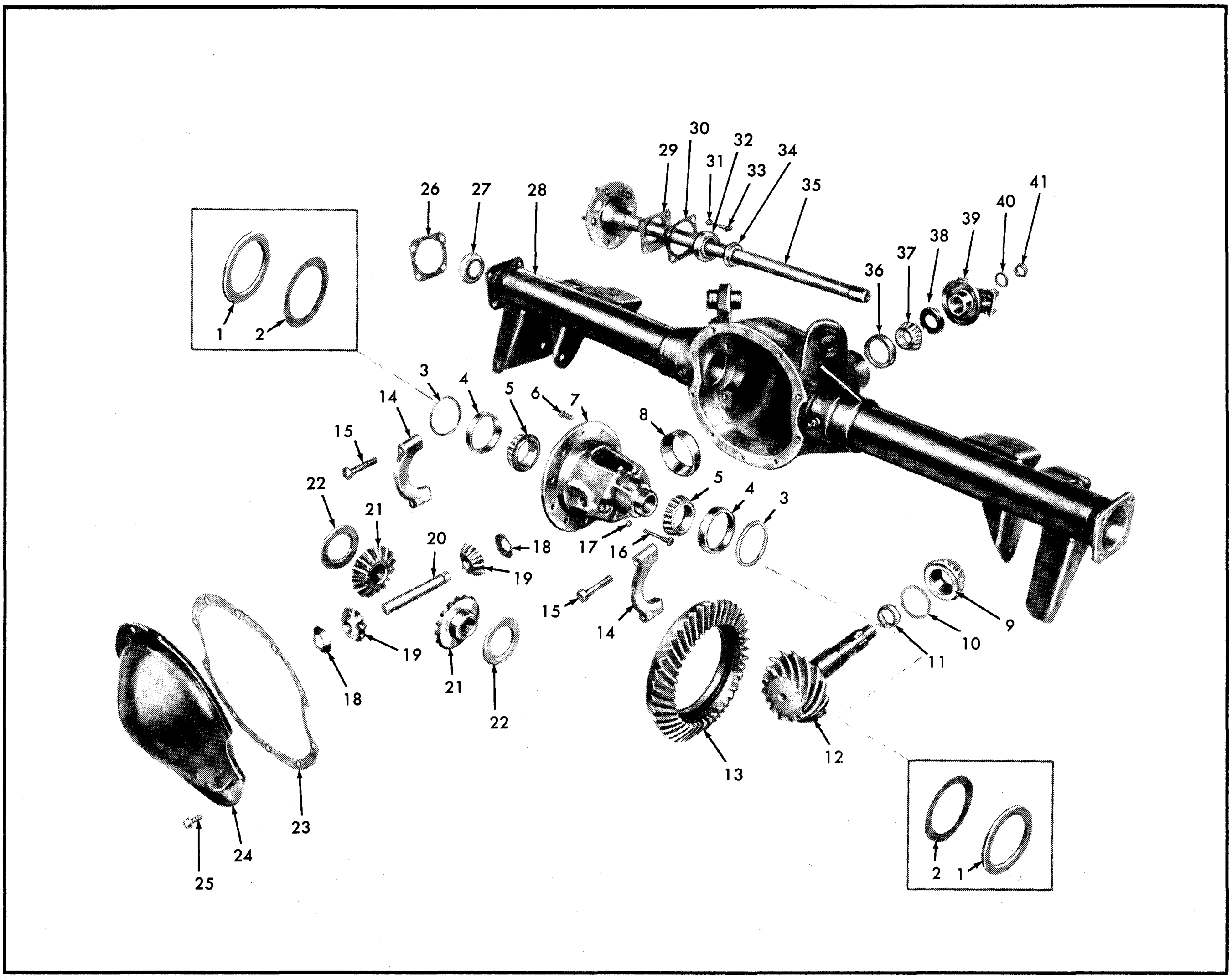


Fig. 4-3 Differential Assembly - Exploded View

1. Spacer (Service)
2. Differential Side Bearing Shim (Service)
3. Differential Side Bearing Shim (Production)
4. Differential Side Bearing Race
5. Differential Side Bearing
6. Ring Gear to Differential Case Bolt
7. Differential Case
8. Rear Pinion Bearing Outer Race
9. Rear Pinion Bearing
10. Drive Pinion Bearing Shim
11. Drive Pinion Bearing Spacer
12. Drive Pinion Gear
13. Ring Gear
14. Differential Side Bearing Cap
15. Cat Bolt
16. Differential Pinion Shaft Lock Bolt
17. Washer
18. Differential Pinion Gear Thrust Washer
19. Differential Pinion Gear
20. Differential Pinion Shaft
21. Differential Side Gear
22. Differential Side Gear Thrust Washer
23. Cover Gasket
24. Cover
25. Cover Bolt
26. Inner Retainer Gasket
27. Axle Shaft Oil Seal
28. Carrier & Tubes Assembly
29. Outer Retainer
30. Outer Retainer Gasket
31. Nut
32. Axle Shaft Bearing
33. Brake Assembly to Housing Bolt
34. Inner Retainer
35. Axle Shaft
36. Front Pinion Bearing Outer Race
37. Front Pinion Bearing
38. Pinion Oil Seal
39. Companion Flange
40. Washer
41. Pinion Nut

### AXLE RATIOS

Ten different axle ratios are available for various car models. They can be identified by a color marking on the outer end of each axle shaft as well as the ratio stamped on the R.H. axle tube adjacent to carrier. Fig. 4-1. (See page 4-24 for Safe-T-Track identification.)

The different axle ratios, engine and transmission combinations available are shown in Fig. 4-4.

REAR AXLE IDENTIFICATION CHART

**REAR AXLE USAGE AND IDENTIFICATION CHART**

| Rear Axle Gear | | Usage | | | | | | | | | | | | | | | | | | | | | Differential | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Model | | | | | | | Transmission | | | | Ratio Release | | | Engine | | | Trail Prov. | | Air Cond. | | | |
| Comb. | Ratio | Temp. Exc. Sta. Wag. | Cust. SEDAN | Cust. COUPE | Sta. Wag. | LEMANS | POLICE | TAXI | 3 Spd. SM | 4 Spd. SM | Air Cool Auto. | Water Cool Auto. | ECON. | STD. | PERF. | 6 CYL. | 326 2 bbl. | 326 H.O. | W/O | WITH | W/O | WITH | Std. Color | Safe-T-Track Color |
| 41:16 | 2.56 | X | X | | | | | | | | X | | | X | | X | | | X | | X | | Gray | Gray & Green |
| | | | | X | X | X | | | | | X | | X | | | X | | | X | | X | | | |
| | | X | X | X | X | X | | | | | | X | | X | | | X | | X | | X | X | | |
| 39:14 | 2:78 | | | X | X | X | | | | | X | | | X | | X | | | X | | X | | Red | Red & Green |
| | | | | | | | | X | | | X | | | X | | X | | | X | | X | X | | |
| | | | | | | | | X | | | | X | | X | | | X | | X | | X | X | | |
| 41:14 | 2.93 | X | X | X | X | X | | | | | X | X | | | X | X | X | | X | | X | | Orange | Orange & Green |
| | | | | | | | X | | | | | X | | X | | | X | | X | | X | X | | |
| 40:13 | 3.08 | X | X | X | X | X | | | | | X | | | X | | X | | | X | | | X | Yellow | Yellow & Green |
| | | | | | | | | X | | | X | | | | X | X | | | X | | X | X | | |
| | | | | | | | | X | | | | X | | | X | | X | | X | | X | X | | |
| | | | | | | | X | | | | X | | | X | | X | | | X | | X | X | | |
| | | X | X | X | | X | | | X | X | | | | X | | X | | | X | | X | | | |
| | | X | X | X | X | X | | | X | X | | | X | | | | X | | X | | X | | | |
| | | | | | | | | X | X | X | | | | X | | | X | | X | | X | X | | |
| 42:13 | 3.23 | X | X | X | X | X | | | | | | X | | X | | | | X | X | | X | X | Brown | Brown & Green |
| | | | | | | | X | | | | X | | | | X | X | | | X | | X | X | | |
| | | | | | | | X | | | | | X | | | X | | X | | X | | X | X | | |
| | | X | X | X | | X | | | X | X | | | | X | | X | | | X | | | X | | |
| | | X | X | X | X | X | | | X | X | | | | X | | | X | | X | | X | X | | |
| | | X | X | X | X | X | | | X | X | | | | X | | | | X | X | | | X | | |
| | | | | | | | X | | X | X | | | | X | | X | | | X | | X | X | | |
| | | X | X | X | | X | | | X | X | | | | Special Order | | X | | | X | X | X* | | | |
| 37:11 | 3.36 | X | X | X | X | X | | | | | X | | | X | | X | | | | X | X | | White | White & Green |
| | | X | X | X | X | X | | | | | | X | | X | | | X | X | | X | X | | | |
| | | | | | X | | | | X | X | | | | X | | X | | | X | | X | X | | |
| | | X | X | X | X | X | | | X | X | | | | X | | | | X | X | | X | | | |
| | | | | | | | | X | X | X | | | | | X | | X | | X | | X | X | | |
| | | | | | | | X | | X | X | | | | X | | X | X | | X | | X | X | | |
| | | X | X | X | X | X | | | | | | X | | Special | | | | X | X | | X | X | | |
| | | X | X | X | | X | | | X | X | | | | Order | | X | | | X | X | X* | X | | |
| | | X | X | X | X | X | | | X | X | | | | | | | X | | X | X | X* | X | | |
| 39:11 | 3.55 | X | X | X | X | X | | | X | X | | | | X | | | X | X | | X | X | X | Blue | Blue & Green |
| | | | | | | | | X | X | X | | | | | X | X | | | X | | X | X | | |
| | | | | | | | X | | X | X | | | | | X | X | X | | X | | X | X | | |
| | | X | X | X | X | X | | | | | | X | | Special | | | | X | X | X | X* | | | |
| | | | | | X | | | | X | X | | | | Order | | X | | | X | X | X* | | | |
| | | X | X | X | X | X | | | X | X | | | | | | | | X | X | | X* | | | |
| 41:11 | 3.73 | X | X | X | X | X | | | X | X | | | | X | | X | | | | X | X | X | Pink | Pink & Green |
| | | X | X | X | X | X | | | X | X | | | | Special Order | | | | X | X | X | X* | | | |
| 39:10 | 3.90 | X | X | X | X | X | | | X | X | | | | Special Order | | | | X | X | X | X* | | | Green |
| 43:10 | 4.30 | X | X | X | X | X | | | X | X | | | | Special Order | | | | X | X | X | X* | | Black | Black & Green |

*Special Radiator Required.

Fig. 4-4 Chart - Rear Axle Usage and Identification

## INSPECTION AND PERIODIC SERVICE
## INSPECTION

### *NEW CAR PRE-DELIVERY INSPECTION*

TORQUE

Check torque specifications at rear axle.

1. All rear suspension control arm bolts should be tightened to 75-100 lb. ft. torque or nut to 60-85 lb. ft. torque.

2. Rear shock absorber nuts to axle housing should be tightened to 55-75 lb. ft. torque and shock absorber to frame bolt and nut 15-25 lb. ft. torque.

3. Universal joint U-bolt nuts should be tightened to 14-20 lb. ft. torque if bolts are found loose.

### *LUBRICATION*

Check differential oil level and, if necessary, add sufficient amount of multi-purpose hypoid gear lubricant to bring level to bottom of filler plug hole.

## PERIODIC SERVICE

### *LUBRICATION*

Lubricant change in the differential is not recommended unless repair work is being done. The differential should be checked for leaks at each chassis lubrication. If there is evidence of leakage the leak should be corrected and lubricant added if needed. Level should be even with bottom of filler plug hole. Rear axle capacity is 3 pints.

Use multi-purpose hypoid gear lubricant in the standard and Safe-T-Track differential. Because of the importance of using factory recommended lubricant, a container of this lubricant is furnished with each service ring gear and pinion set or differential carrier assembly. This lubricant is also available through regular parts channels (part number 531536).

### *SHOCK ABSORBERS*

Give visual inspection for leaks and jounce car at each lubrication period to see that shock absorbers are in operative condition. If inoperative or if leaks are found, the unit should be replaced.

## MINOR SERVICE AND REPAIRS

*NOTE: Most rear axle service repairs can be made with the rear axle assembly in the car by raising the rear end of the car with the rear axle hanging on the shock absorbers. Rear axle lubricant may be drained by backing-out all cover bolts and breaking cover loose at the bottom.*

### *COMPANION FLANGE—REMOVE AND REPLACE*

*NOTE: When replacing companion flange, it is important that new flange be properly installed to provide correct pinion bearing preload. The following procedure must be used to insure incorrect pinion bearing adjustment.*

1. With rear wheels off the floor, turn rear wheels and rap brake backing plates with a soft hammer to ensure that brakes are free.

2. Turn down lock plates and remove U-bolts which hold rear universal joint to companion flange. Use a heavy rubber band or tape to hold bearings onto journal to prevent loss of bearing rollers when joint is disconnected if retainer strap has been removed (Fig. 4-5).

3. Using pound inch torque wrench KMO-652 with adapter KMO-653 and socket placed over drive pinion nut, turn pinion two or three revolutions to ensure free movement, and then take a torque reading while rotating pinion to measure bearing preload (Fig. 4-6). Record reading.

*NOTE: Additional clearance to check preload can be obtained between differential and body by raising body a few inches by means of a jack or stand placed under frame at rear.*

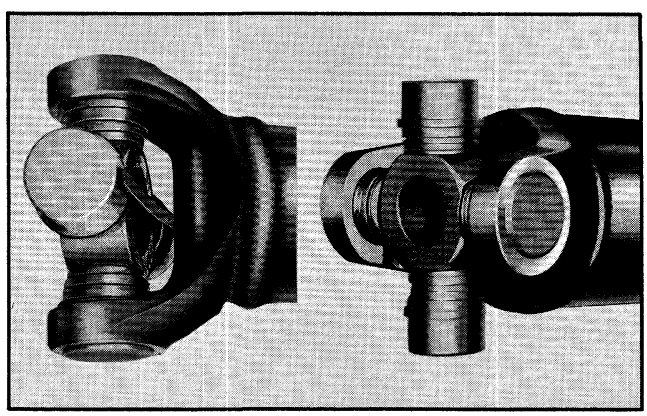


Fig. 4-5 Bearings Held in Place By Retainer Strap

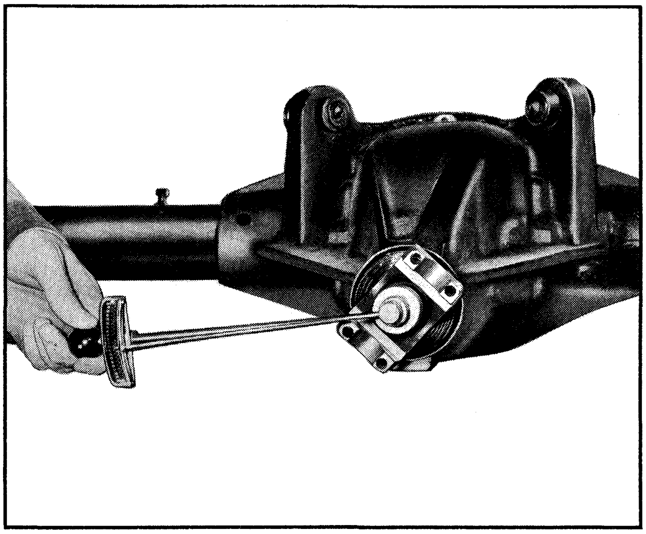


Fig. 4-6 Checking Pinion Bearing Preload

4. Hold companion flange with tool J-8614-1 (Fig. 4-7) and remove drive pinion nut and washer using heavy duty socket.

5. Remove companion flange using puller J-8614-2 and 3 (Fig. 4-8).

6. Install new companion flange and install washer and nut. Hold companion flange with tool J-8614-1 and tighten nut only a little at a time, stopping frequently to check preload (step 3). Tighten nut to reading noted in step 3; however, if reading obtained in step 3 was less than 12 lb. in., increase preload to 12-20 lb. in.

7. Connect universal joints. Use new lock plates and tighten U-joint to companion flange "U" bolt nuts to 14-20 lb. ft. torque. Turn up lock plate ears against flats of "U" bolt nuts.

### *PINION BEARING OIL SEAL— REMOVE AND REPLACE*

*NOTE: Since inspection of companion flange after removal may reveal damage to this part necessitating its replacement, preload reading of pinion bearings must be checked prior to removing flange so proper preload can be maintained should new flange be required.*

1. With rear wheels off the floor, turn rear wheels and rap brake backing plates with a soft hammer to ensure that brakes are free.

2. Turn down lock plates and remove "U" bolts which hold rear universal joint to companion flange.

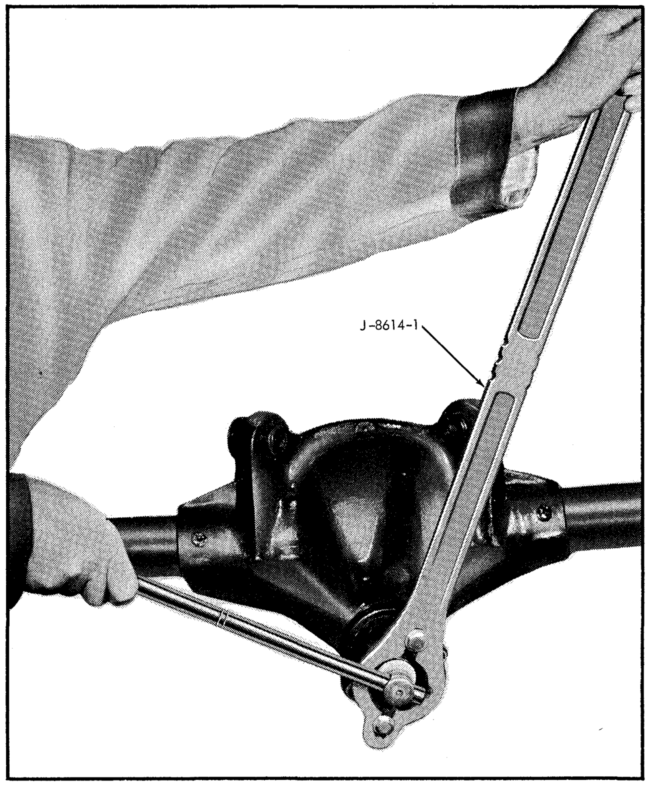



Fig. 4-7 Removing Pinion Nut

Use a heavy rubber band or tape to hold bearings onto journal to prevent loss of bearing rollers when joint is disconnected if retainer strap has been removed (Fig. 4-5).

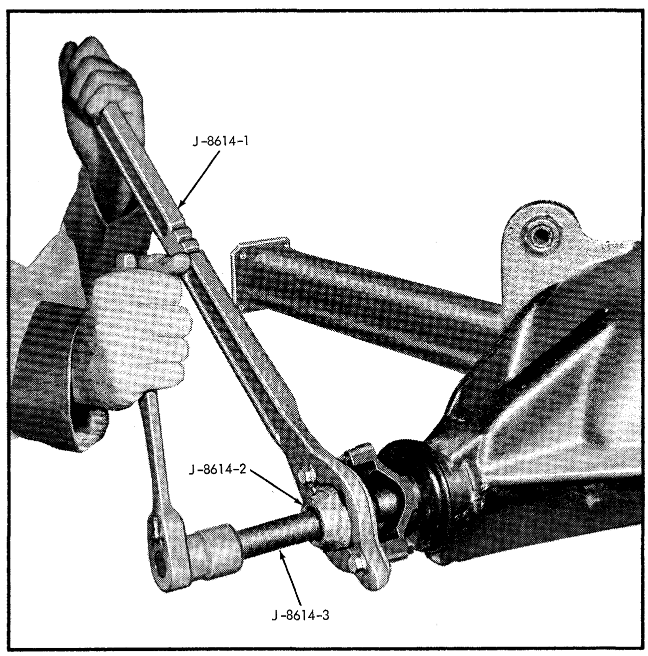



Fig. 4-8 Removing Companion Flange

3. Scribe a line on the end of the pinion stem extending down along the side of the stem threads and onto the companion flange nut.

4. Punch a small mark on the line at the pinion stem end, and at the top of the lock nut close to the pinion stem threads.

5. Using pound inch torque wrench KMO-652 with adapter KMO-653 and socket placed over drive pinion nut, turn two or three revolutions to ensure free movement, and then take a torque reading while rotating pinion to measure bearing preload (Fig. 4-6). Record reading.

*NOTE: Additional clearance to check preload can be obtained between differential and body by raising body a few inches by means of a jack or stand placed under the frame at rear.*

6. Count the number of exposed threads from the top of the pinion stem to the lock nut and remove the lock nut with a heavy duty socket while holding the companion flange with J-8614-1 (Fig. 4-7).

7. Remove companion flange using puller J-8614-2 & 3 (Fig. 4-8).

8. Remove oil seal by prying it out of carrier with a pointed tool, using care to keep tool away from the exposed front bearing.

*CAUTION: Use care to keep dirt and other foreign matter out of exposed front pinion bearing.*

9. Oil lip of new seal with clean engine oil. Coat outer diameter of seal case with suitable sealer. Install seal by tapping into place, using J-21128, (Fig. 4-9).

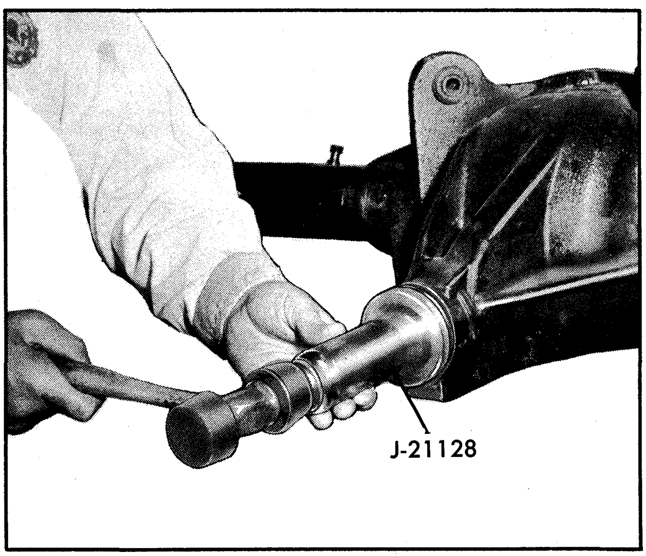



Fig. 4-9 Installing Pinion Oil Seal

10. Before installing companion flange, inspect for nicks, scratches or burred surfaces that may damage the seal. If any such damage is evident, hone carefully or install new flange.

a. If a new companion flange is installed, refer to the appropriate steps under COMPANION FLANGE - REMOVE AND REPLACE.

b. If inspection shows the original companion flange to be satisfactory, replace by holding companion flange with J-8614-1 and install nut to exactly the same position with the old companion flange, making sure punched holes and scribe line are in alignment. Tighten lock nut an additional 1/32" beyond this alignment.

*CAUTION: DO NOT exceed the additional tightening of the nut by a distance of more than 1/32" from its original position as tightening the nut in excess of this amount will disturb the pinion and ring gear tooth contact pattern.*

11. Connect rear universal joint. Use new lock plates and tighten U-joint to companion flange "U" bolt nut to 14-20 lb. ft. torque. Turn up lock plate ears against flats of "U" bolt nuts.

## AXLE SHAFT AND/OR AXLE SHAFT BEARING AND/OR BEARING OIL SEAL AND/OR WHEEL BOLT—REMOVE AND REPLACE

### REMOVE AXLE SHAFT ASSEMBLIES

Design allows for axle shaft end play up to .032" loose. This end play can be checked with the wheel and brake drum removed by measuring the difference between the end of the housing and the axle shaft flange while moving the axle shaft in and out by hand.

End play over .032" is excessive. Compensating for all of the end play by inserting a shim inboard of the bearing in the housing is not recommended since it ignores the end play of the bearing itself, and may result in improper seating of the gasket or backing plate against the housing. If the end play is excessive, the axle shaft and bearing assembly should be removed and the cause of the excessive end play determined and corrected.

1. Remove wheels. Both right and left wheels have right hand threads.

2. Remove brake drums.

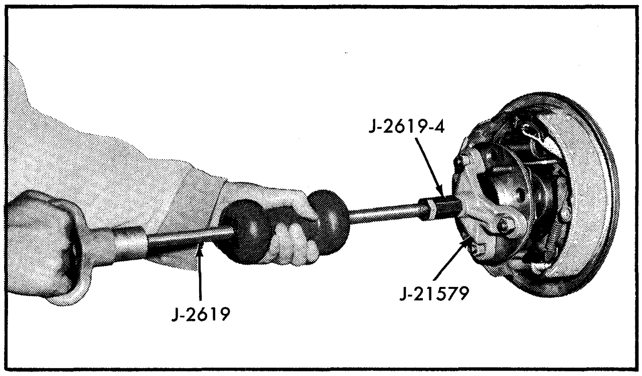



Fig. 4-10 Removing Axle Shaft

3. Remove nuts holding retainer plates and brake backing plates. Pull retainers clear of bolts, and reinstall two lower nuts finger tight to hold brake backing plate in position.

4. Pull out axle shaft assemblies using puller J-21579 and adapter J-2619-4 with a slide hammer J-2619, see Fig. 4-10.

REMOVE AND REPLACE AXLE SHAFT BEARING

1. Press axle shaft bearing and inner retainer off using split plate J-8916-1 (Fig. 4-11).

2. Press new axle shaft bearing against shoulder on axle shaft using installer J-21022 with holder J-6407. See Fig. 4-12.

*CAUTION: Outer retainer plate which retains bearing in housing must be on axle shaft before bearing is installed; a new outer retainer gasket can be installed after bearing. Use care not to wedge outer retainer between bearing and shoulder of shaft.*

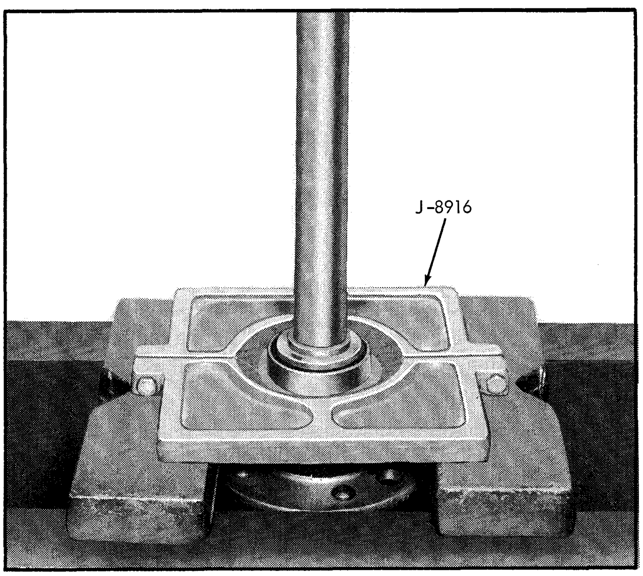



Fig. 4-11 Removing Axle Shaft Bearing and Inner Retainer

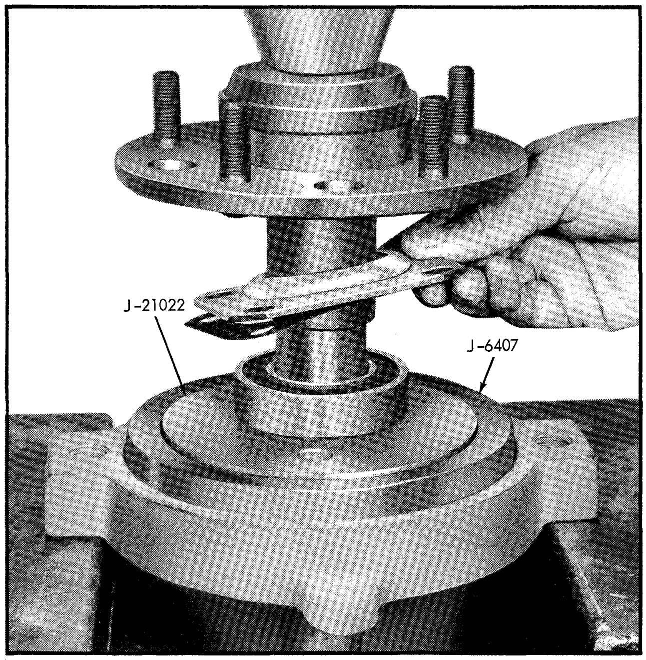



Fig. 4-12 Installing Axle Shaft Bearing

*NOTE: DO NOT press bearing and inner retainer on in one operation.*

3. Press new inner retainer ring against bearing using installer J-21022, Fig. 4-13.

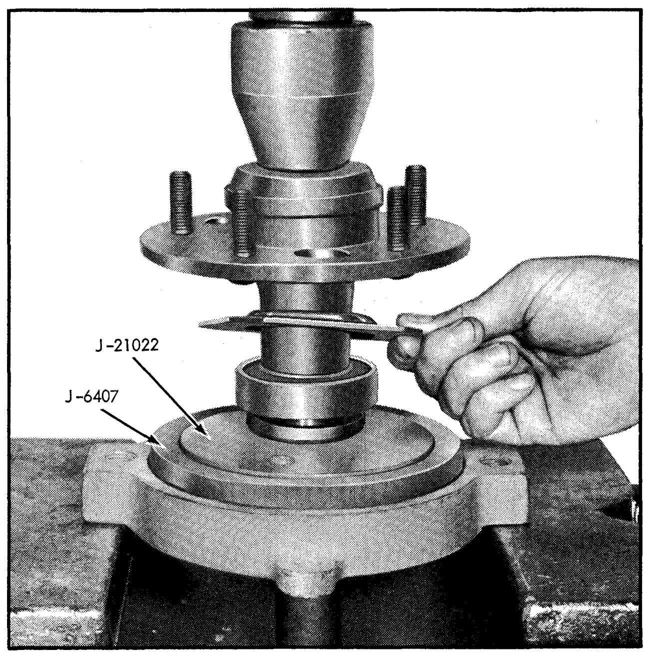



Fig. 4-13 Installing Inner Retainer

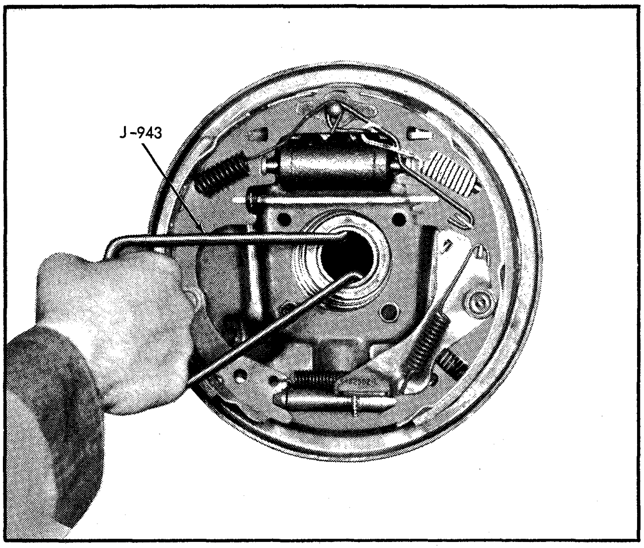


Fig. 4-14 Removing Axle Shaft Seal

REMOVE AND REPLACE REAR WHEEL BOLT

1. To remove and install a rear wheel bolt, axle shaft assembly must be out of car. Remove rear wheel bolt by pressing from axle flange.

2. Install new rear wheel bolt by pressing through axle flange. Check new bolt for looseness; if bolt is loose, axle shaft must be replaced.

REMOVE AND REPLACE AXLE SHAFT SEAL

1. Insert tongs J-943 (Fig. 4-14) behind seal and pull straight out to remove seal.

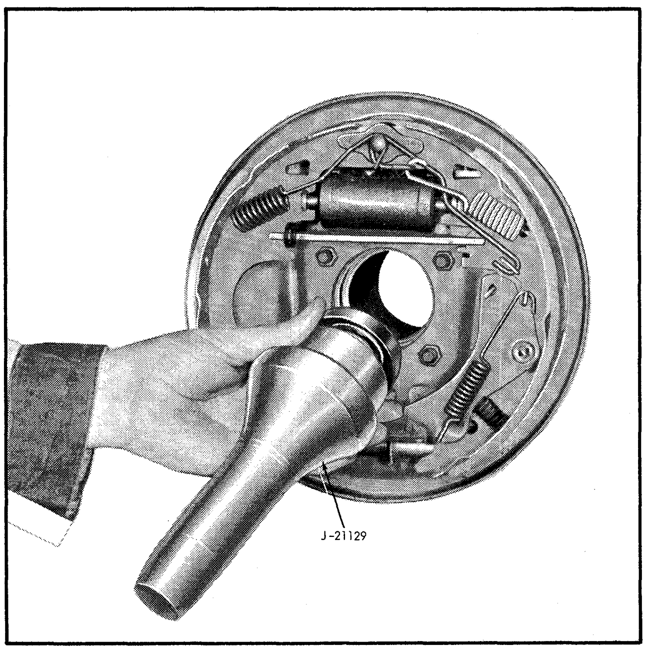


Fig. 4-15 Positioning Seal on Tool

2. Apply sealer to O.D. of new seal.

3. Position seal over installer J-21129 (Fig. 4-15) and drive straight into axle housing until tool bottoms on bearing shoulder in housing.

REPLACE AXLE SHAFT ASSEMBLIES

1. Apply a coat of wheel bearing grease in bearing recess of housing. To help prevent damage to the lip of the wheel bearing seal when installing the axle shaft and to ensure lubricant on the seal lip during the first few miles of operation, the axle shaft should also be lightly lubricated with axle lubricant from the sealing surface to approximately 6 inches inboard.

2. *IMPORTANT: Install new axle housing to brake backing plate gasket.*

3. Install brake assembly to axle housing bolts and place brake backing plate in proper position.

4. With a new outer retainer gasket in proper position, carefully insert axle shaft assembly into housing until splines engage differential.

*CAUTION: Do not let shaft drag on oil seal.*

5. Drive axle shaft assembly into position.

6. Place the new outer retainer gasket (Fig. 4-3) and retainer over studs and install nuts. Tighten nuts to 40-55 lb. ft. torque.

7. Install brake drums over wheel bolts.

8. Install wheels and tighten wheel nuts 70-85 lb. ft. torque.

## MAJOR REPAIRS

### *REMOVAL AND INSTALLATION OF REAR AXLE ASSEMBLY*

It is not necessary to remove the rear axle assembly for any normal repairs. However, if the housing is damaged, the rear axle assembly may be removed and installed using the following procedure.

REMOVE REAR AXLE ASSEMBLY

1. Raise rear of car high enough to permit working underneath. Place a floor jack under center of

axle housing so it just starts to raise rear axle assembly. Place car stands solidly under body members on both sides.

2. Disconnect rear universal joint from companion flange by removing two "U" bolts. Use a heavy rubber band or tape to hold bearings onto journal to prevent loss of bearing rollers when joint is disconnected if retainer strap has been removed (Fig. 4-5). Support propeller shaft out of the way.

3. Remove both axle shafts.

4. Support both brake backing plates out of way.

5. Disconnect rear brake hose bracket by removing top cover bolt. Remove brake line from housing by bending back tabs.

6. Loosen remaining cover bolts, break loose cover about 1/8" and allow lubricant to drain.

7. Disconnect shock absorbers at axle housing. Lower jack under axle housing until rear springs can be removed.

8. Disconnect upper control arms at axle housing.

9. Disconnect lower control arms at axle housing and remove rear axle assembly out from under car.

REPLACE REAR AXLE ASSEMBLY

1. Rest car solidly on stands placed under body side members, with rear end of car high enough to permit working underneath. Position axle assembly under car.

2. Connect lower control arms to axle housing.

3. Connect upper control arms to axle housing.

4. Place rear springs in position and jack axle housing upward until shock absorbers will reach.

5. Connect shock absorbers and tighten nuts to 55-75 lb. ft. Connect lower control arms and tighten bolts to 75-100 lb. ft. or nuts to 60-85 lb. ft. Connect upper control arm bolts and tighten to 75-100 lb. ft. or nuts to 60-85 lb. ft.

6. Install new axle housing to brake backing plate and outer retainer gaskets, then place backing plates in proper position & install axle shafts and wheels.

7. Connect rear universal joint to companion flange. Install new lock plates and nuts. Tighten nuts evenly to 14-20 lb. ft. Bend ears of lock plates up against flat side of nuts.

*CAUTION: "U" bolt nuts must be torqued as specified, as over-tightening will distort bearings and cause early failure.*

8. Connect rear brake hose bracket at top cover bolt and bend tabs over brake lines on housing.

9. Fill rear axle with specified gear lubricant.

REMOVE AND REPLACE DIFFERENTIAL

1. With rear wheels off the floor, turn rear wheels and rap brake backing plates with a soft hammer to ensure that brakes are free.

2. Remove both axle shafts.

3. Turn down lock plates and remove "U" bolts which hold rear universal joint to companion flange. Use a heavy rubber band or tape to hold bearings onto journal to prevent loss of bearing rollers when joint is disconnected if retainer strap has been removed (Fig. 4-5).

4. Thoroughly clean differential housing cover and surrounding area of axle housing to avoid dirt entering housing or falling on the gears.

5. Drain oil by loosening all cover attaching bolts and then break loose cover about 1/8 inch.

6. Allow oil to drain throughly then remove attaching bolts and remove cover from housing.

## *PRE-REPAIR INVESTIGATION*

A close examination of the differential prior to disassembly will often reveal valuable information as to the extent and type of repairs or adjustments necessary. The information thus gained, coupled with the report of malfunctioning, will provide a basis for determining the degree of disassembly required. Since the frequent causes of axle noise are improper backlash or side bearing preload, or both, a few simple adjustments may be all that is necessary to correct a discrepancy.

Therefore, before removing the differential from the housing the following checks should be made, the results recorded and analysed.

A. Side Bearing Preload (see page 4-22)

B. Backlash (see page 4-22)

C. Pinion Bearing Preload (see page 4-6)

D. Red Lead Test

Use care at all times to keep dirt and other foreign matter, such as grinder dust, soot, or sand, away from differential to prevent possibility of subsequent failure of differential.

## RED LEAD TEST

It is very important that tooth contact be tested before differential carrier assembly is disassembled and before it is installed. Allowable variations in the carrier or pinion rear bearing may cause pinion to be too far away from, or close to, ring gear. Thus, tooth contact must be tested and corrected if necessary or the gears may be noisy. Review GEAR TOOTH NOMENCLATURE before proceeding. Page 4-13.

1. Mix a small amount of powdered red lead (available from paint manufacturers and suppliers) with a drop of engine oil and apply this mixture sparingly to all ring gear teeth using a medium stiff brush. When properly used, area of pinion tooth contact will be visible when hand load is applied.

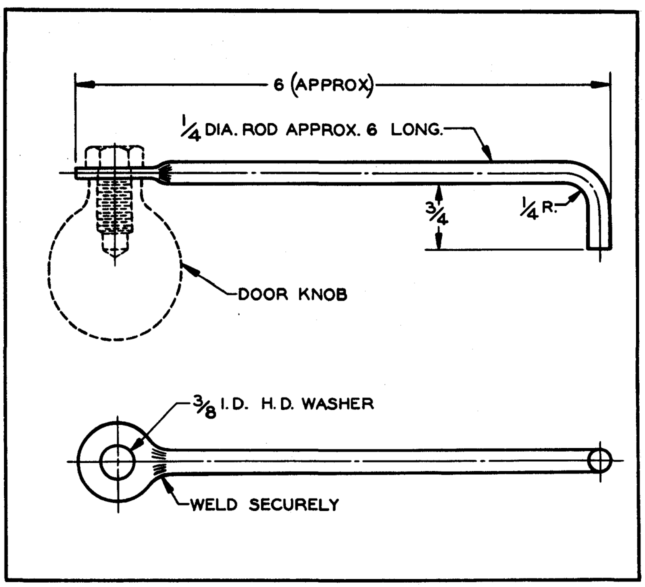



Fig. 4-16 Differential Cranking Tool

2. Tighten bearing cap bolts to 60-75 lb. ft. torque and tap heads of bolt intermittently while tightening to ensure proper seating of caps and sufficient tightness.

3. Insert crank (Fig. 4-16) in companion flange and, while turning, apply pressure to back side of ring gear with hand. A test made without loading the gears will not give a satisfactory pattern. Turn companion flange with crank so that ring gear rotates one full revolution, then reverse rotation so that ring gear rotates one revolution in opposite direction. Excessive turning of ring gear may indicate good tooth pattern because one or two teeth are making proper contact.

*NOTE: The crank in Fig. 4-16 may be easily made as follows:*

a. Weld a 3/8" heavy duty flat washer to a piece of 1/4" diameter rod approximately 6" long and form as shown.

b. Tap door knob for 3/8" bolt and attach knob to crank as shown. Leave bolt loose enough to permit knob to turn.

4. Closely inspect tooth pattern on ring gear to determine whether pressure lines are apparent.

*NOTE: If observation reveals pressure lines are present (dark narrow band at edge of pattern), examine for pressure line position on drive side (gear curving outward or outside of arc, or convex) and also coast side of ring gear (side curving inward or inward side of arc, or concave). If lines on drive side are too deep and coast side are too high (near the heel and toe respectively), then additional shims to bring pinion gear out (to provide a more centrally located tooth pattern on ring gear) will only place the pressure line deeper into the tooth on drive side and farther out on the coast side which will result in a noisy operating axle. This does not mean the ring gear and pinion are not good or should be destroyed. It only means that they will not operate quietly in the carrier in which they are presently installed. These same parts may operate quietly in another carrier when tooth pattern is checked.*

Removing backlash moves ring gear into pinion gear, driving the pinion deeper into the ring gear. Whenever pressure lines are noted, as explained above, install another ring gear and pinion set.

5. Observe pattern on ring gear teeth and compare with Fig. 4-17.

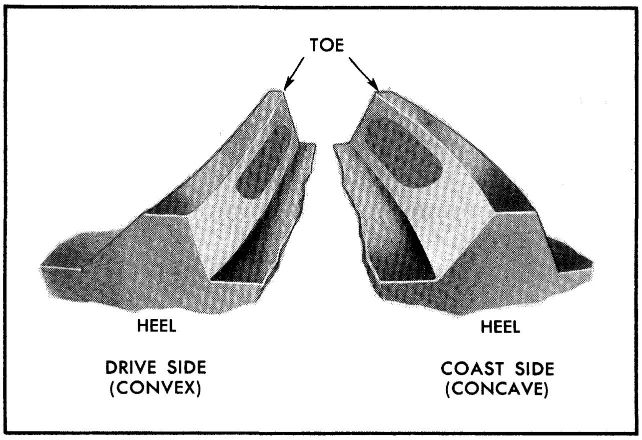



Fig. 4-17 Desired Tooth Contact Under Light Load

GEAR TOOTH NOMENCLATURE

The side of the ring gear tooth which curves outward, or is convex, is referred to as the "drive" side; concave side is "coast" side. The end of the tooth nearest center of ring gear is referred to as the "toe" end; end of tooth farthest away from center is "heel" end. Toe end of tooth is smaller than heel end.

***EFFECTS OF INCREASING LOAD ON TOOTH CONTACT PATTERN***

When "load" on ring and pinion gear is increased, such as when car is accelerated from standstill or from normal drive, the tooth contact will tend to spread out, and under very heavy load will extend from near toe to near heel. The entire contact also tends to shift toward heel under increasingly heavier loads and will become somewhat broader with respect to tops and bottoms of teeth. The patterns obtained by red lead tests, dependent upon degree of "loading", approximate a normal light load, and for this reason will not cover the entire face of the ring gear, but will extend only about halfway (Fig. 4-17). The important thing to note is that the contact pattern is centrally located up and down on the face of the ring gear.

ADJUSTMENTS EFFECTING TOOTH CONTACT

Two adjustments can be made which will affect tooth contact pattern: backlash, and position of drive pinion in carrier. The effects of bearing preloads are not readily apparent on (hand loaded) red lead tests; however, these adjustments should be within specifications before proceeding with backlash and drive pinion adjustments.

Backlash is adjusted by means of the side bearing adjusting shims which move the entire case and ring gear assembly closer to or farther from drive pinion. (The adjusting shims are also used to set side bearing preload.)

The position of the drive pinion is adjusted by increasing or decreasing the shim pack between the pinion head and inner race of rear bearing. The shim pack is used in the differential to compansate for manufacturing tolerances. Increasing shim pack thickness will move pinion closer to centerline of ring gear. Decreasing shim pack thickness will move pinion farther away from centerline of ring gear.

EFFECTS OF BACKLASH ON TOOTH PATTERN

The terms "excess" and "insufficient" refer to settings which are greater than .009" or less than .005" as specified. With respect to tooth contract patterns, "excess" refers to backlash which, although less than .009", is more than necessary to provide desired pattern. Similarly, "insufficient" refers to backlash which, although .005" or more, is less than necessary to provide desired pattern.

Excess backlash, provided pinion is properly positioned, will give a high heel pattern on both drive and coast sides (Fig. 4-18). Decreasing backlash by moving case and ring gear assembly closer to pinion will cause pattern to move toward toe end and down toward center of tooth on both drive and coast sides.

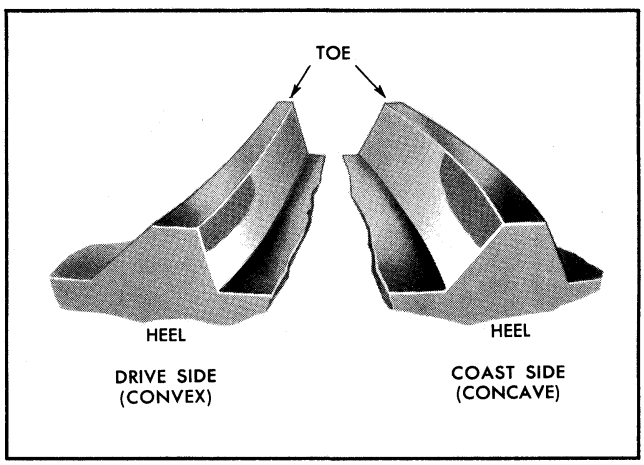



Fig. 4-18 Tooth Pattern - Excessive Backlash

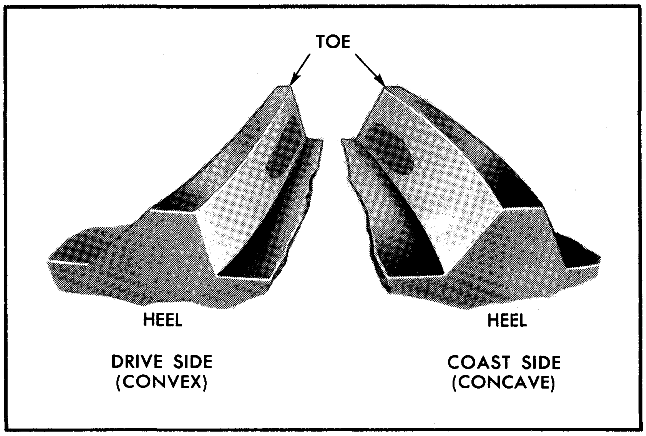



Fig. 4-19 Tooth Pattern - Insufficient Backlash

Insufficient backlash, provided pinion is properly positioned, will give a low toe pattern on both drive and coast sides (Fig. 4-19). Increasing backlash will cause pattern to move toward heel end and up toward top of tooth on both drive and coast sides.

## EFFECTS OF PINION POSITION ON TOOTH PATTERN

When drive pinion is too far away from centerline of ring gear, the pattern will be a high heel contact on drive side and a high toe contact on coast side (Fig. 4-20), provided backlash is within specifications of .005" to .009". Moving pinion closer to centerline of ring gear by increasing shim pack thickness will cause the high heel contact on drive side to lower and move toward toe; the high toe contact on coast side will lower and move toward heel (Fig. 4-21).

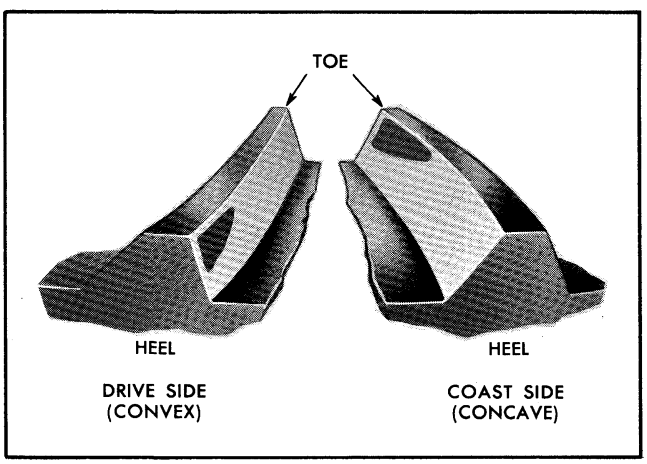



Fig. 4-20 Tooth Pattern - Pinion Too Close to Ring Gear (Shim Pack Thickness Insufficient)

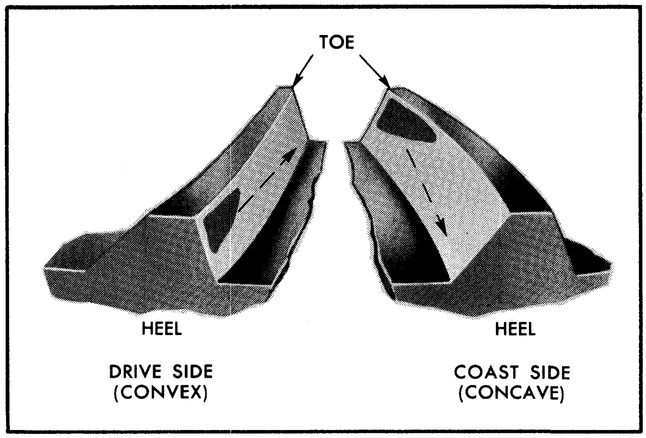



Fig. 4-21 Effect on Pattern as Shim Pack is Increased

When pinion is too close to ring gear, pattern will be a low toe contact on drive side, and a low heel contact on coast (Fig. 4-22), provided backlash is within specifications of .005" to .009". Moving pinion farther away from ring gear by decreasing shim pack thickness will cause low toe contact on drive side to raise and move toward heel; low heel contact on coast will raise and move toward toe (Fig. 4-23).

## ***DIFFERENTIAL ASSEMBLY—OVERHAUL***

### REMOVE DIFFERENTIAL CASE ASSEMBLY

*NOTE: Before removing case from housing be sure the checks under pre-repair investigation have been completed.*

1. Remove the four bearing cap bolts.

2. As a safety precaution re-install the bearing caps with four 7/16-14 x 4-1/2 cylinder head bolts finger tight.

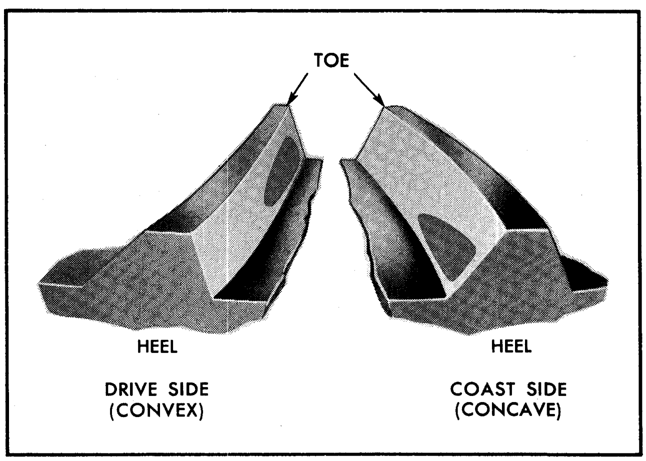



Fig. 4-22 Tooth Pattern - Pinion too Close to Ring Gear (Shim Pack Thickness Insufficient)

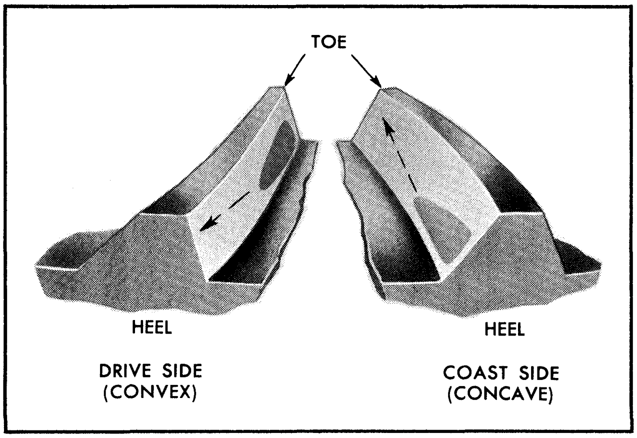



Fig. 4-23 Effect on Tooth Pattern as Shim Pack is Decreased

3. Remove two ring gear to case assembly bolts. Install ring gear and case remover J-21322 and slide hammer J-2619 as shown in Fig. 4-24.

4. Loosen case from housing with slide hammer until it falls free. Safety bolts installed in step 2 will catch assembly.

5. Support case assembly in one hand and remove head bolts. CAREFULLY remove case so as not to let bearing races or shims fall from housing.

*NOTE: Bearing caps are marked "R" & "L" to make sure they are reassembled correctly. Place right and left bearing outer race and shims in sets with marked bearing caps. Measure thickness of each shim and record.*

DISASSEMBLE DIFFERENTIAL
CASE ASSEMBLY

1. Before disassembling differential case, inspect differential side bearings for visible damage of rollers and outer races.

2. Place one outer race onto its mated inner race and roller assembly and turn slowly, applying hand load.

3. If bearing outer race turns smoothly and no visible damage is found, bearing can probably be reused.

4. Repeat above operation with other outer race and mated bearing and check for smoothness.

*NOTE: Both side bearings and their races are mated parts. If either bearing is to be replaced, its mating outer race must also be replaced.*

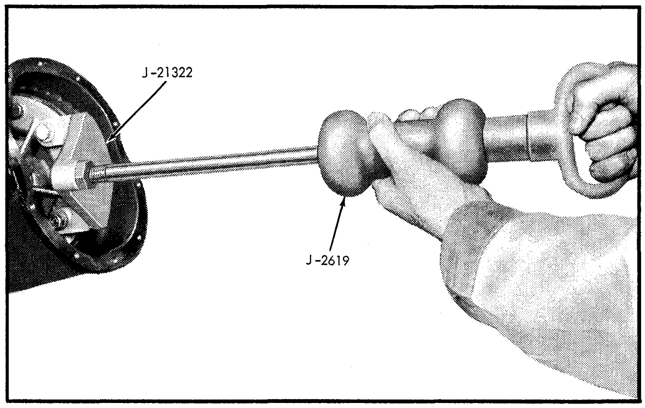



Fig. 4-24 Removing Differential Case

5. Inspect fit of inner races on case hubs by prying against shoulders at puller recesses. Bearing inner races must be tight on case hubs.

*NOTE: If either is loose on case, the entire case must be replaced.*

6. If bearing inspection indicates that bearings should be replaced, insert differential case in vise and, using side bearing puller J-986-P, and adapter J-8107 remove side bearing (Fig. 4-25).

*CAUTION: Make certain ends of puller arms are firmly seated in recesses in sides of hubs and fully against inner race of bearing.*

7. Turn differential case in vise and remove other side bearing in same manner.

8. Remove pinion shaft lock screw and washer.

9. Drive pinion shaft out of case, using brass drift (Fig. 4-26).

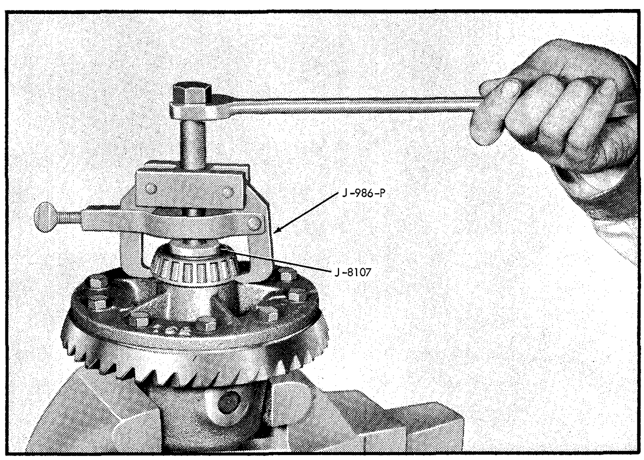



Fig. 4-25 Removing Differential Side Bearing

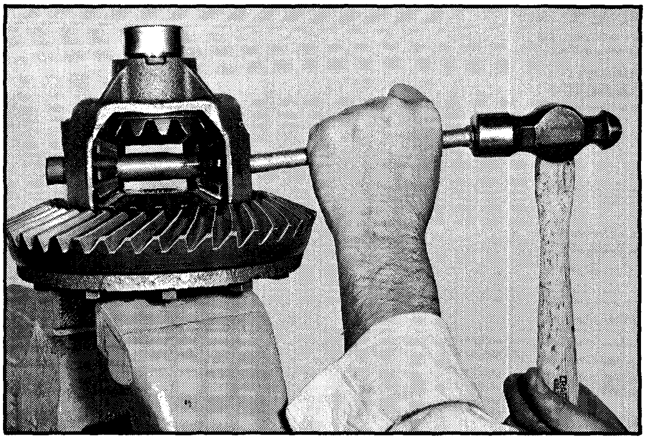


Fig. 4-26 Removing Pinion Shaft

10. Remove differential pinion gears, thrust washers and side gears and place in sets so they may be reinstalled in original position.

11. If ring gear is to be removed, clamp case in vise so jaws are 90° to pinion shaft holes and remove ten ring gear retaining bolts.

12. Partially re-install two bolts on opposite sides of ring gear.

13. Remove ring gear from case by alternately tapping on bolts.

*CAUTION: Do not pry between case and ring gear.*

CLEANING AND INSPECTION

1. Thoroughly clean differential case and inspect, paying particular attention to ring gear mounting flange, ring gear pilot, and side bearing hubs.

2. Remove nicks and burrs with mill file.

*NOTE: If new case is to be used, thoroughly clean new case in suitable solvent, making certain bolt holes and bolts are clean of steel fillings and foreign material.*

3. Clean side gears, pinion gears and thrust washers with suitable solvent and inspect for excessive wear.

4. Thoroughly clean ring gear and inspect back side for any adhering material which may effect runout.

5. Position ring gear on case and check fit of gear on flange and pilot. Should be from .002 tight to .001 loose. If ring gear easily falls into position, it must be replaced.

*NOTE: If ring gear is replaced, pinion gear must also be replaced as they are only serviced in matched sets.*

7. Replace parts as necessary and coat with clean engine oil before installing in case.

DIFFERENTIAL CASE ASSEMBLY - ASSEMBLE

1. After making sure that mating surfaces are clean and free of burrs, position ring gear on case so holes are in line.

2. Lubricate attaching bolts with clean engine oil and install.

3. Pull ring gear onto case by alternately tightening bolts around case. When all bolts are snug, tighten bolts evenly and alternately across diameter to 55-65 lb. ft. torque.

*CAUTION: Do not use hammer to force ring gear on case.*

4. Place side gear thrust washers over side gear hubs and install side gears in case. If some parts are reused, replace in original sides.

5. Position one pinion (without washer) between side gears and rotate gears until pinion is directly opposite from loading opening in case. Place other pinion between side gears so that pinion axle holes are in line, then rotate gears to make sure holes in pinions will line up with holes in case.

6. If holes line up, rotate pinions back toward loading opening just enough to permit sliding in pinion thrust washers.

7. Install pinion shaft. Install pinion shaft retaining bolt. Torque to 10-20 lb. ft. (Fig. 4-27).

8. Remove differential case from vise and lubricate outer bearing surfaces.

9. Using J-21028 press on bearing with arbor press (Fig. 4-28).

10. Reverse differential case, support previously installed bearing with J-8980 and press on right side bearing, using J-21028 (Fig. 4-29).

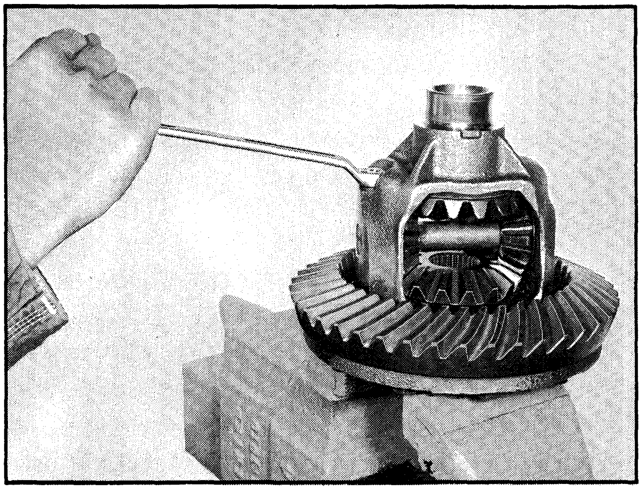


Fig. 4-27 Installing Pinion Shaft Locking Bolt

REMOVE PINION ASSEMBLY

1. Check pinion bearing preload as described on page 4-6. If there is no preload reading, check for looseness of pinion assembly by shaking. Looseness indicates need for bearing replacement. If assembly is run long with very loose bearings, ring gear and pinion will also require replacement.

2. Install holder J-8614-01 on pinion flange by using two 5/16" bolts with flat washers. Remove pinion nut and washer. See Fig. 4-30.

3. Pull companion flange from pinion using puller J-8614-02 in holder J-8614-01. To install puller, back out puller screw, insert puller through holder, and rotate 1/8 turn. See Fig. 4-31.

4. Remove pinion assembly. If necessary, tap pinion out with soft hammer, while being careful to guide pinion with hand to avoid damage to bearing outer races.

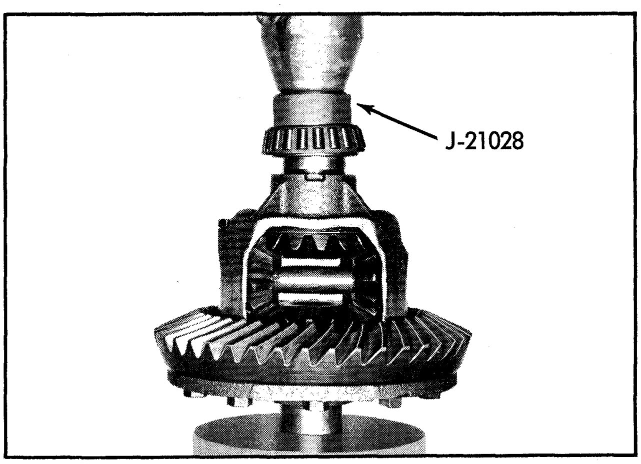



Fig. 4-28 Installing Right Differential Side Bearing

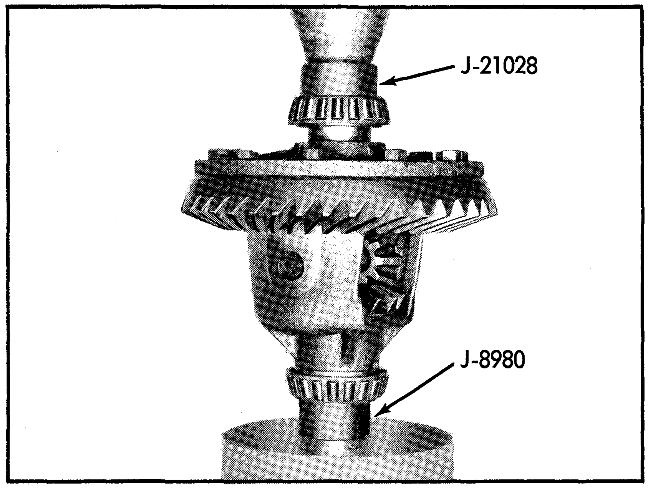



Fig. 4-29 Installing Left Differential Side Bearing

DISASSEMBLE PINION ASSEMBLY

*NOTE: Both front bearing and outer race and rear bearing and outer race are mated parts. If either bearing is to be replaced, its mating outer race must also be replaced.*

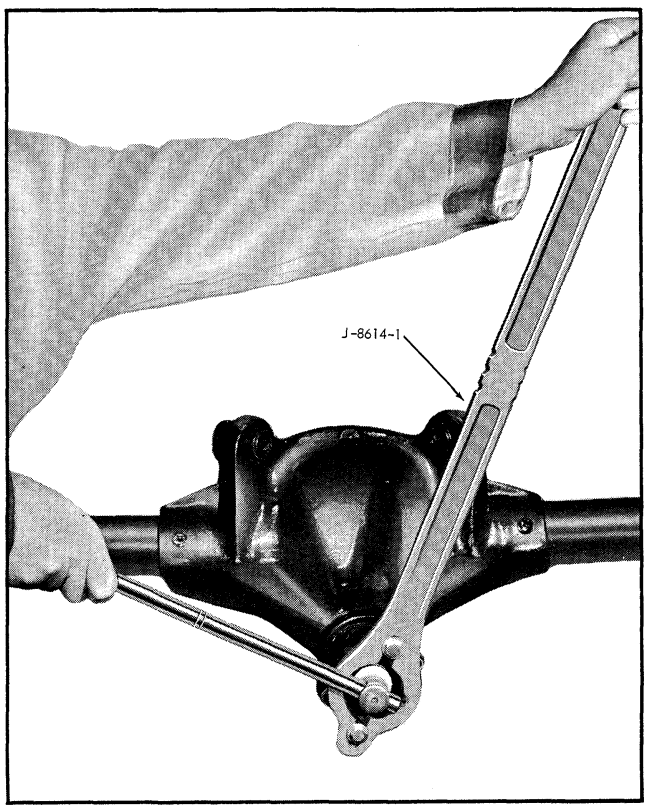



Fig. 4-30 Removing Pinion Nut

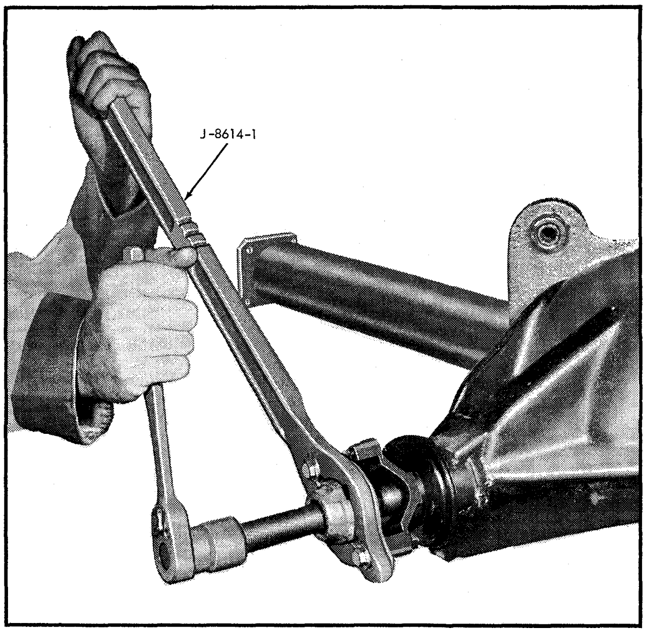



Fig. 4-31 Removing Companion Flange

1. If rear pinion bearing is to be replaced, or pinion depth setting changed, remove rear pinion bearing from pinion shaft using Remover J-21493 with Holder J-6407. See Fig. 4-32.

2. If rear pinion bearing is to be replaced, drive outer race from carrier using a drift in slots provided for this purpose.

3. Pry pinion oil seal from carrier and remove front pinion bearing. If this bearing is to be replaced, drive outer race from carrier using a drift.

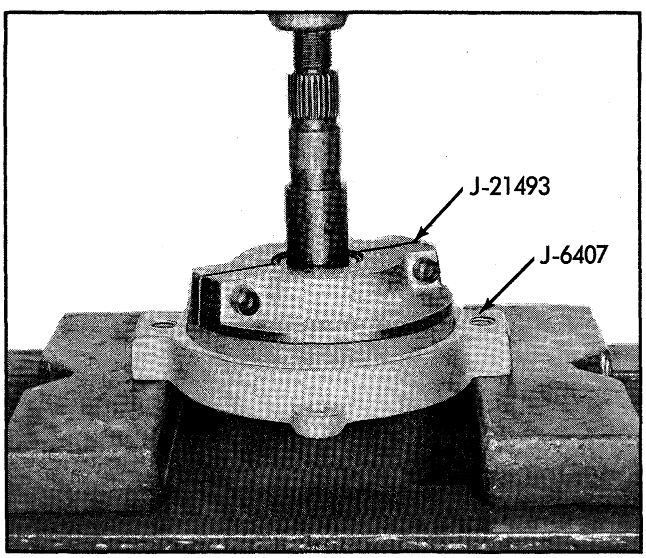



Fig. 4-32 Removing Rear Pinion Bearing

CLEANING AND INSPECTION

1. Check drive pinion stem and gear for excessive wear.

*NOTE: Ring gears and pinions are matched in sets at the factory and are serviced only in sets. Never attempt to replace either a right gear or pinion without its mating member.*

2. Thoroughly clean and inspect carrier for cracks or other damage.

3. Ensure that oil passages in carrier are clean and clear.

4. Inspect bearing cap bolt threads in carrier and bearing caps to ensure they are free of metal filings and chips.

5. Carefully inspect pinion bore and shoulders against which pinion bearing outer races seat to ensure they are free of burrs, nicks, or material which would prevent proper seating of bearing outer races.

*NOTE: If axle housing (carrier and tube assembly) is being replaced, thoroughly clean and inspect new housing, paying particular attention to machined surfaces in bearing caps and carrier. Be sure all metal filings and foreign material are removed in the bearing cap bolt holes in the carrier. Ensure that bearing caps seat squarely on carrier; use mill file lightly to remove nicks and burrs.*

### DIFFERENTIAL ASSEMBLY—ASSEMBLE

INSTALL PINION BEARING OUTER RACES

1. If rear pinion bearing is to be replaced, install new outer race using installer J-6197 with driver handle J-8092. See Fig. 4-33.

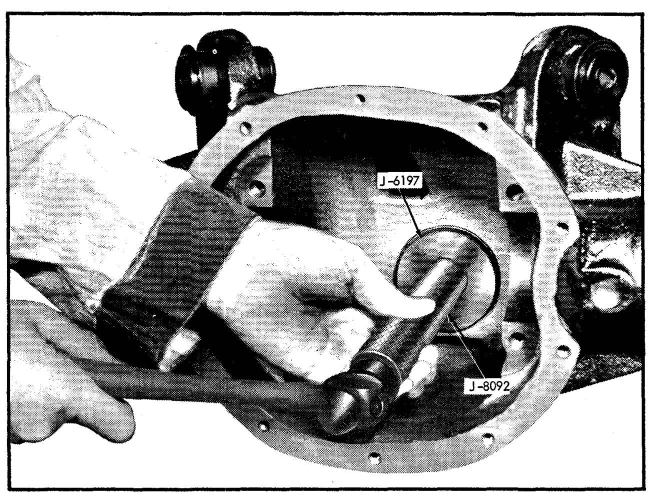



Fig. 4-33 Installing Rear Pinion Bearing Outer Race

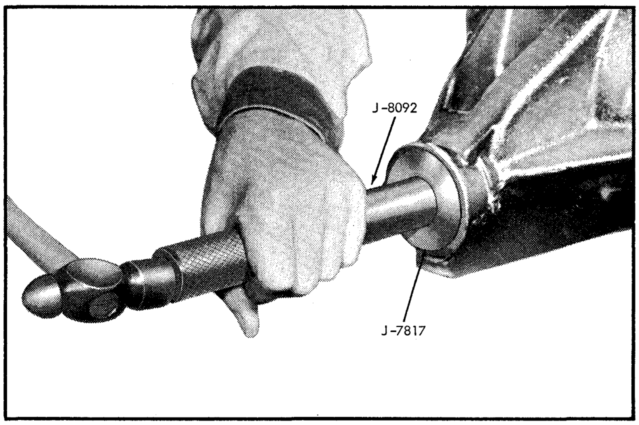



Fig. 4-34 Installing Front Pinion Bearing Outer Race

2. If front pinion bearing is to be replaced, install new outer race using installer J-7817 with driver handle J-8092. See Fig. 4-34.

SETTING PINION DEPTH

Whenever a new housing (carrier and tube assembly) is to be used, and/or new bearings and races, or the pre-repair investigation indicates the drive pinion bearing shim should be changed, the pinion bearing shim thickness (pinion depth) must be determined.

Ring and pinion gear sets are matched in a special test machine. All production pinions are marked in thousandths of an inch if they vary from a "nominal" setting. When a pinion is marked "+" (plus), it means that the pinion is located too far away from the centerline of ring gear and shims must be added to move the pinion closer to the ring gear and position the pinion at the nominal setting. When a pinion is marked "-" (minus), it means that the pinion is located too close to the centerline of the ring gear and shims must be removed to move the pinion away from the ring gear and position the pinion at the nominal setting. All pinions produced for service are "nominal" or "zero" pinions and are unmarked.

Pinion depth is set with pinion setting gauge J-8619 which consists of the following: (1) J-8619-1, indicator gauge, (1) J-8619-2 master gauge, (2) J-8619-10 discs, (1) J-8619-11 gauge plate, (1) J-8619-12 pilot disc, (1) J-8619-13 bolt and nut. A J-8001 dial indicator must also be used with the indicator gauge J-8619-1.

Although production pinions are marked, neither production nor service pinions have a gauging tooth. The pinion setting gauge provides in effect a "nominal" or "zero" pinion as a gauging reference.

1. Make certain all of the gauge parts are clean, particularly the discs and center of the indicator gauge; also check the centering hole and disc pads on the master gauge.

2. Install the J-8619-10 discs on the indicator gauge with the larger diameter towards the inside. Install the small (spherical) contact button on the stem of the dial indicator and mount the dial indicator on the indicator gauge.

3. Place the indicator gauge on the master gauge, Fig. 4-35 so that the spring loaded center is engaged in the centering hole, the inner, large diameter portion of each disc contacts the master gauge pads.

4. Center the indicator contact button on the indicator pad and lock the indicator by tightening the thumb screw.

5. Hold yoke down firmly with both discs contacting the horizontal and vertical pads on master gauge, and set dial indicator at zero.

6. Lubricate front and rear pinion bearings; then position them in their respective races in the carrier. While holding bearings in place, install gauge plate J-8619-11 in carrier on rear pinion bearing inner race and place pilot on surface of front pinion bearing. Insert stud J-8619-13 through pilot, front and rear bearings and thread it into gauge plate. See Fig. 4-36.

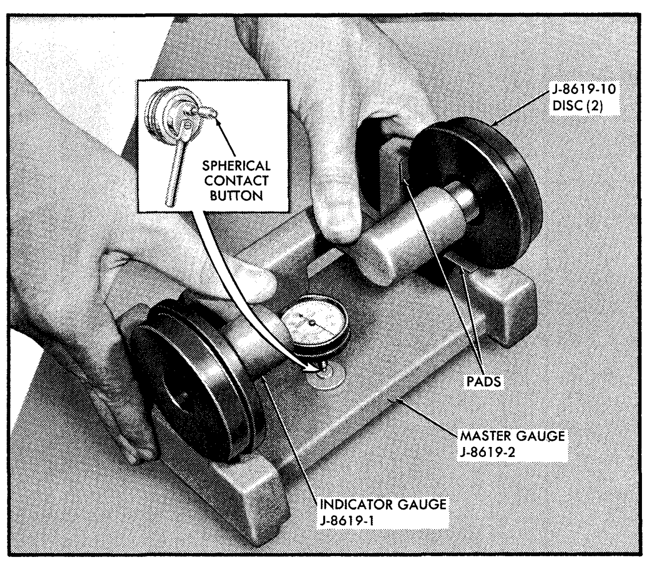



Fig. 4-35 Zeroing Pinion Depth Setting Gauge

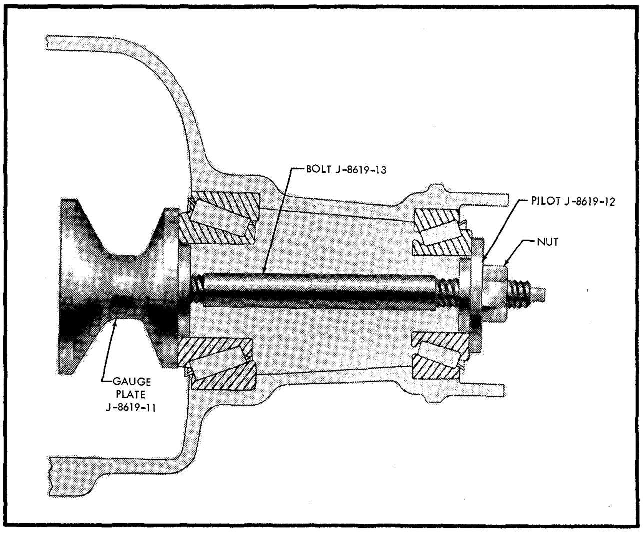



Fig. 4-36 Securing Gauge Plate in Carrier

7. Install a nut on stud J-8619-13. Hold stud stationary with wrench positioned over flats on ends of stud and tighten nut until a reading of 15 to 25 in. lbs. is obtained when rotating gauge plate assembly with an inch pound torque wrench.

8. Make certain differential bearing support bores are free of burrs. Install indicator gauge in carrier so that small diameter outer portion of discs rest in differential bearing pedestal support bores. Spring loaded center of gauge must be located in centering hole of gauge plate and contact button of dial indicator must be positioned to bear against outer edge of gauge plate top surfaces. See Fig. 4-37.

9. Press gauge yoke down firmly toward gauging plate. Record the number of thousandths the dial

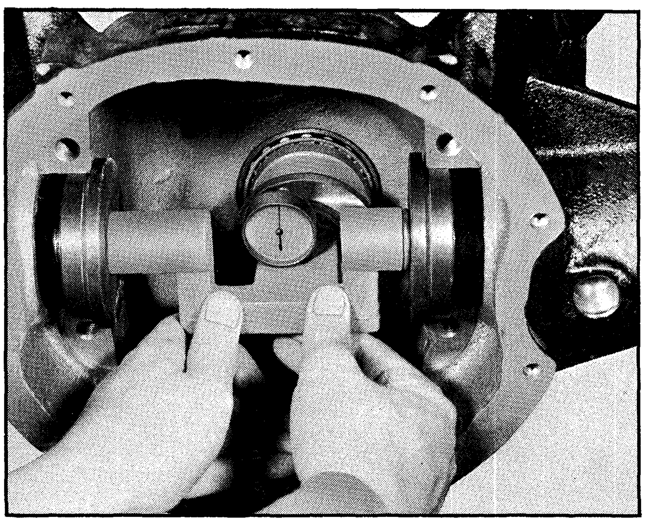


Fig. 4-37 Checking Pinion Depth

Fig. 4-38 Pinion Shim

moves from zero. NOTE: Read gauge counterclockwise. Example: If pointer is at 60, it would be read as 40. Remove indicator gauge and recheck "zero setting" on master gauge to make sure this setting was not disturbed by handling.

10. If zero setting is still correct, remove gauging set-up and both bearings from the carrier.

11. Select the correct pinion shim to be used during pinion reassembly on the following basis:

*NOTE: Twenty (20) shims are available in increments of (.001") one thousandths from .020 to .039, Fig. 4-38. If a shim from .040 to .050 is needed use two shims.*

a. If the production pinion is being reused and the pinion is marked "+" (plus), the correct shim will have a thickness equal to the indicator gauge reading found in step 9, plus the amount specified on the pinion.

b. If the production pinion is being reused and the pinion is marked "-" (minus), the correct shim will have a thickness equal to the indicator gauge reading found in step 9, less the amount specified on the pinion.

c. If a production or service pinion is being used (no marking), the correct shim will have a thickness equal to the indicator gauge reading found in step 9.

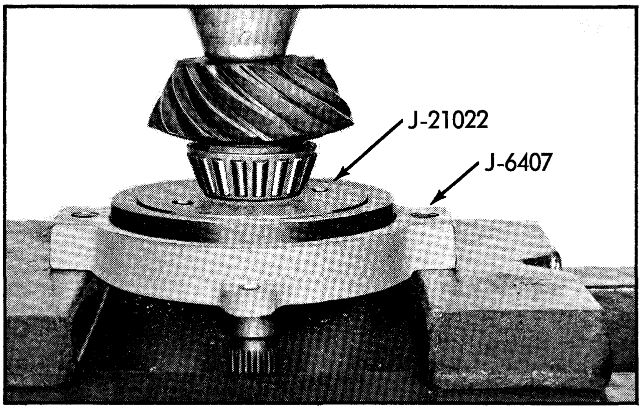



Fig. 4-39 Installing Rear Pinion Bearing

12. Loosen stud J-8619-13 and remove gauge plate J-8619-11, washer J-8619-12, and both bearings from case.

13. Examine ring gear and pinion for nicks, burrs, or scoring. Any of these conditions will require replacement of gear set. If gears are in good condition, slide pinion shim on to pinion shaft and install rear pinion bearing on pinion using installer J-21022 and holder J-6407 in a press or as shown in Fig. 4-39.

INSTALL PINION ASSEMBLY AND
ADJUST PINION PRELOAD

1. Position pinion assembly in carrier and install new collapsible spacer.

2. Place front pinion bearing in position on pinion. Hold pinion fully forward and drive bearing over pinion until seated, using installer J-21128. See Fig. 4-40.

3. Coat O.D. of pinion oil seal with sealing compound and install in carrier using installer J-21128.

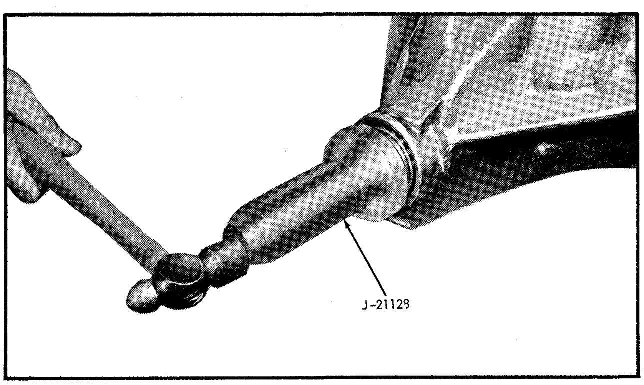



Fig. 4-40 Installing Front Pinion Bearing

4. Coat lips of pinion oil seal; seal surface of pinion flange with gear lube. Install companion flange on pinion by tapping with a soft hammer until a few pinion threads project through flange.

5. Install pinion washer nut. Hold companion flange with holder J-8614-01. While intermittently rotating pinion to seat bearings, tighten pinion nut until end play begins to be taken up.

*CAUTION: When no further end play is detectable, and when holder J-8614 will no longer pivot freely as pinion is rotated, preload specifications are being neared. Further tightening should be done only after preload has been checked.*

6. Check preload by using a lb. in. torque wrench as shown in Fig. 4-41.

*CAUTION: After preload has been checked, final tightening should be done very cautiously. For example, if when checking, preload was found to be 5 lb. in., additional tightening of the pinion nut as little as 1/8 turn can add additional lb. in. drag. Therefore, the pinion nut should be further tightened only a little at a time and preload should be checked after each slight amount of tightening. Exceeding preload specifications will compress the collapsible spacer too far and require its replacement.*

7. While observing the preceeding caution, carefully set preload drag to 20-30 lb. in. on new bearings or 12-20 lb. in. on used bearings.

8. Rotate pinion several times to assure that bearings have been seated. Check preload again. If drag has been reduced by rotating pinion, re-set preload to specification.

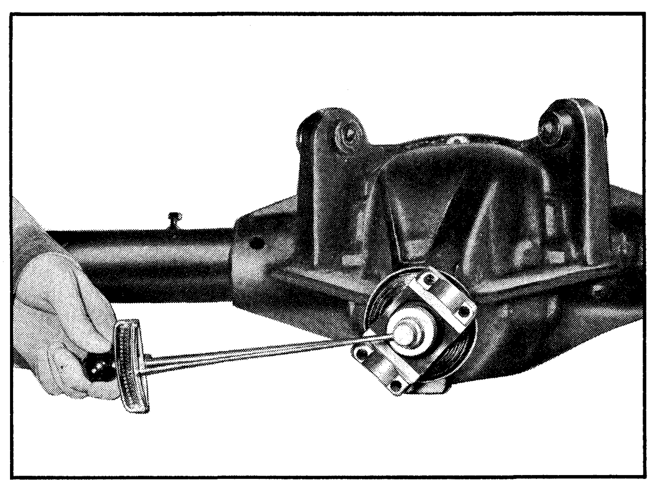


Fig. 4-41 Checking Pinion Bearing Preload

INSTALL DIFFERENTIAL CASE AND ADJUST SIDE BEARING PRELOAD

Differential side bearing preload is adjusted by changing the thickness of the right and left shims an equal amount. By changing the thickness of both shims equally, the original backlash is unchanged.

Production shims vary in thickness from .210 to .252 in increments of two thousandths (.002). Whenever a case assembly is removed from the housing, the production shims are to be measured for thickness and discarded. Upon assembly a service shim spacer of .170 thickness and a service shim (available in increments of .002 from .040 to .082) must be used. Do not attempt to reinstall the production shims as they are cast iron and may break when tapped into place.

1. Before installation of case assembly, make sure that side bearing surfaces are clean and free of burrs. Lubricate side bearings with gear lube. If original bearings are being reused, they must be used with original outer races.

2. Place differential case with bearing outer races in position in carrier.

3. Install a service spacer (.170 thick) between each race and carrier housing.

4. If new bearings are being used install a right and left service shim of appropriate thickness which when added to the .170 spacer will equal the thickness of the original shim. If original bearings are being used install a right and left service shim which when added to the .170 spacer will be .002 thicker than the original shim.

5. Slip left shim between spacer and bearing race, then tap right shim carefully into place, Fig. 4-42.

6. As a safety precaution, install bearing caps using four 7/16-14 x 4-1/2 cylinder head bolts.

7. Rotate differential case several complete turns to seat bearing. Check bearing preload using a lb. in. torque wrench connected at ring gear attaching bolt. With wrench projecting approximately straight out, bearing preload should read 30-40 lb. in. with new bearings, or 20-30 lb. in. with reused bearings. Fig. 4-43. If preload is not according to these specifications, increase shim thickness on each side .002" for each additional 10 lb. in. preload desired, or decrease shim thickness .002" on each side for each 10 lb. in. preload to be subtracted.

8. When preload is correctly adjusted, leave four safety head bolts and caps in position as a safety precaution while performing following backlash checking operation.

ADJUSTING DIFFERENTIAL BACKLASH

1. Rotate differential case several times to seat bearings, then mount dial indicator as shown in Fig. 4-44. Use a small button on indicator stem so that contact can be made near heal end of tooth. Set dial indicator so that stem is as nearly as possible in line with gear rotation and perpendicular to tooth angle for accurate backlash reading.

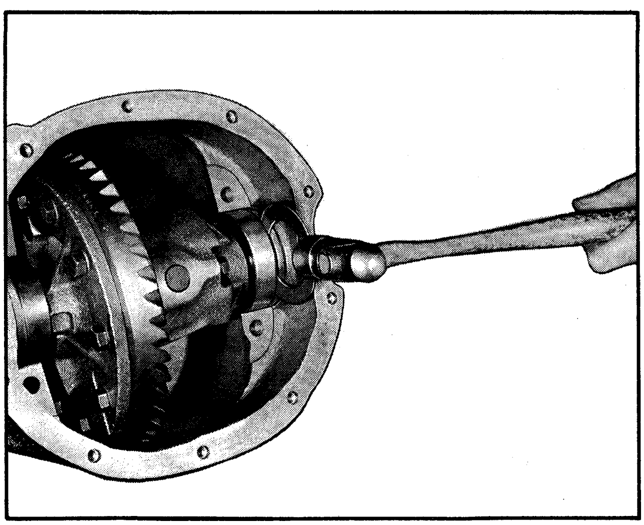


Fig. 4-42 Installing Differential Side Bearing Adjusting Shims

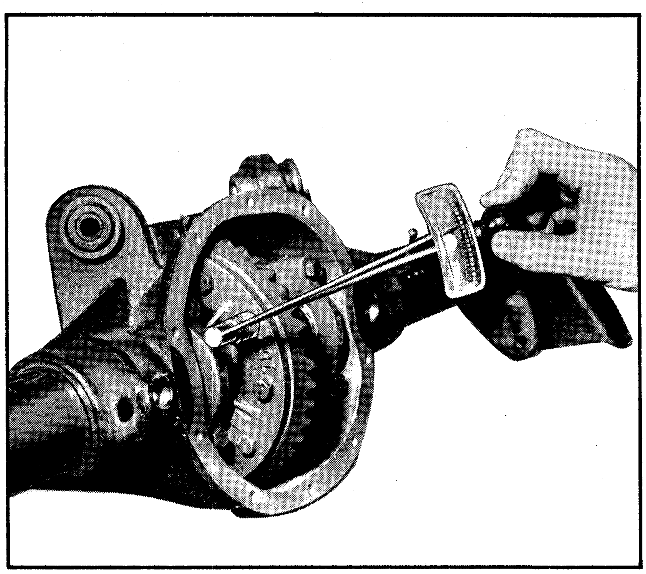


Fig. 4-43 Checking Differential Side Bearing Preload

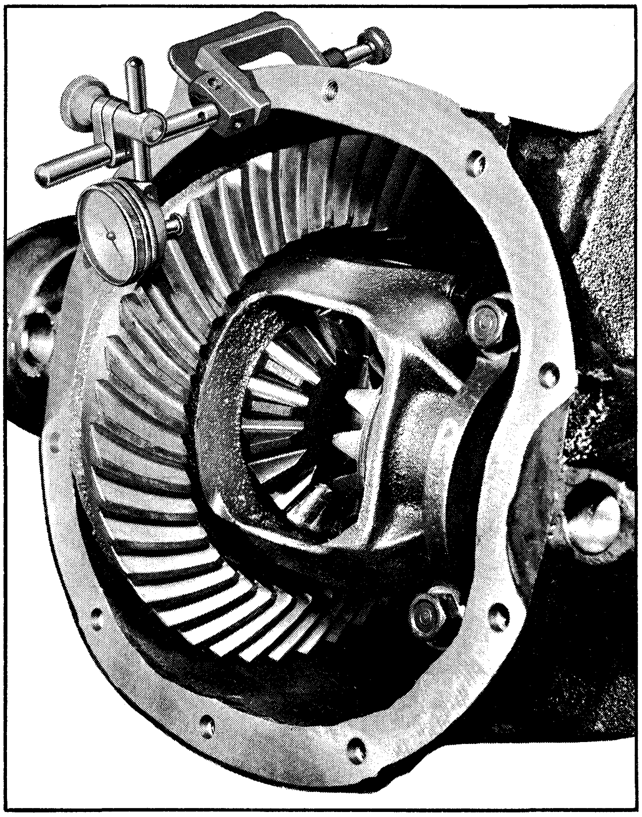


Fig. 4-44 Checking Ring Gear to Pinion Gear Backlash

2. With pinion locked to carrier, check gear lash at 3 or 4 points around ring gear. Lash must not vary over .002" around ring gear. If variation is over .002" check for burrs, uneven bolting conditions or distorted case flange, and make corrections as necessary.

3. Gear lash at the point of minimum lash should be .005" to .009" for all new gears. If original gear set having a wear pattern is being reinstalled, original gear lash should be maintained with ± .001".

4. If gear backlash is not within specifications, correct by increasing thickness of one differential shim and decreasing thickness of other shim the same amount. In this way, correct differential bearing preload will be maintained. Shift .002" in shim thickness for each .001" change in backlash desired. If backlash is .001" too much, decrease thickness of right shim .002" and increase thickness of left shim .002". If backlash is .002" too little, increase thickness of right shim .004" and decrease thickness of left shim .004".

5. When backlash is adjusted to specifications remove four safety head bolts and install bearing cap bolts; tighten to 60-75 lb. ft. torque.

6. Check tooth contact pattern with red lead test.

*NOTE: It may be necessary to readjust the backlash to obtain the correct tooth contact pattern. On high mileage gear sets where a definite wear pattern has been established it may be necessary to exceed .009 backlash to obtain the desired tooth contact. It is important, however, not to exceed .009 backlash on new gear sets.*

*If readjusting the backlash doesn't give the correct tooth contact pattern, the pinion depth must be readjusted.*

7. When correct tooth contact pattern is obtained, install new gasket and cover on housing. DO NOT USE GREASE TO RETAIN GASKET. Insert two upper cover bolts through cover and gasket and carefully install. Be sure gasket is flat and not twisted between cover and housing. Be sure all cover bolts pass through gasket.

*IMPORTANT: Install brake hose bracket and tighten bolts to 20-30 lb. ft. torque. Wait 20 minutes and retorque bolts to 20-30 lb. ft.*

## REPLACE AXLE SHAFT ASSEMBLIES

1. Apply a coat of wheel bearing grease in bearing recess of housing. To help prevent damage to the lip of the wheel bearing seal when installing the axle shaft and to ensure lubricant on the seal lip during the first few miles of operation, the axle shaft should also be lightly lubricated with axle lubricant from the sealing surface to approximately 6 inches inboard.

2. *IMPORTANT: Install new axle housing brake backing plate gasket.*

3. Install brake assembly to axle housing bolts and place brake backing plate in proper position.

4. With a new outer retainer gasket in proper position, carefully insert axle shaft assembly into housing until splines engage differential.

*CAUTION: Do not let shaft drag on oil seal.*

5. Drive axle shaft assembly into position.

6. Place new outer retainer gasket (Fig. 4-3) and retainer over studs and install nuts. Tighten nuts to 40-45 lb. ft. torque.

7. Install brake drums over wheel bolts.

8. Install wheels and tighten wheel nuts 70-85 lb. ft. torque.

# SAFE-T-TRACK DIFFERENTIAL

## GENERAL DESCRIPTION

The Safe-T-Track differential is available as optional equipment on all rear axle ratios of 1964 Tempests. They can be identified by a tag attached to the lower right section of the axle assembly cover and the letter "L" stamped after the ratio adjacent to the housing on the right tube. (Fig. 4-45) It is designed to direct the major driving force to the wheel with the greater traction, thereby reducing the possibility of the car becoming stuck while driving under adverse conditions. Unlike the conventional differential, when one wheel is on a slippery surface (ice, snow, mud, etc.) the car will still move since both wheels are frictionally connected together and rotating at the same speed, allowing the wheel on the dry surface to provide the necessary traction.

Rough roads, crushed stone, railroad tracks, etc. also do not adversely affect rear wheel action. With a conventional differential, when one wheel bounces free of the road, it picks up speed. When this rapidly spinning wheel contacts the road again it causes shock loads to the suspension and drive train. With the Safe-T-Track differential the free wheel continues to rotate at the same speed as the wheel on the road, thereby minimizing shock.

Likewise the Safe-T-Track differential is superior to the conventional differential under conditions of deceleration, cornering and braking.

All rear axle parts of cars equipped with the Safe-T-Track differential are interchangeable with those equipped with the conventional differential except for the case assembly. It is similar in all respects to the conventional case assembly with the addition of cone clutches behind each side gear. The frictional surface of these cones consists of a coarse spiral thread that provides passages for the flow of lubricant. The cones are statically preloaded with six springs (against the cone cavities in each half of the case assembly) to provide an internal resistance to differential action under low tractive conditions at one rear wheel. Fig. 4-46

The case assembly is held together with six bolts and in addition to the above parts also houses the differential pinion shaft, pinion gears, thrust washers and the two piece spring thrust block. Fig. 4-47.

### *OPERATION*

The Safe-T-Track differential operates in reverse and deceleration as well as forward speeds. Torque is applied by the drive pinion to the ring gear which is bolted to the case assembly thereby causing it to rotate. The preload force from the springs plus the inherent separating force between the pinion gears and side gears as the case rotates, forces the clutch cones against the case assembly. Since the clutch cones are splined to the axle shafts, the shafts are in effect locked together and rotate with the case assembly.

When turning corners, the axles are automatically unlocked as the torque created by differential action overcomes the calibrated spring load on the clutch cones allowing them to overrun.

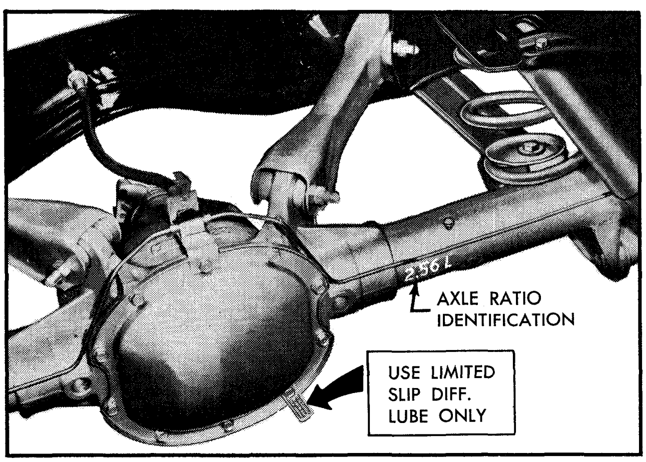



Fig. 4-45 Safe-T-Track Identification

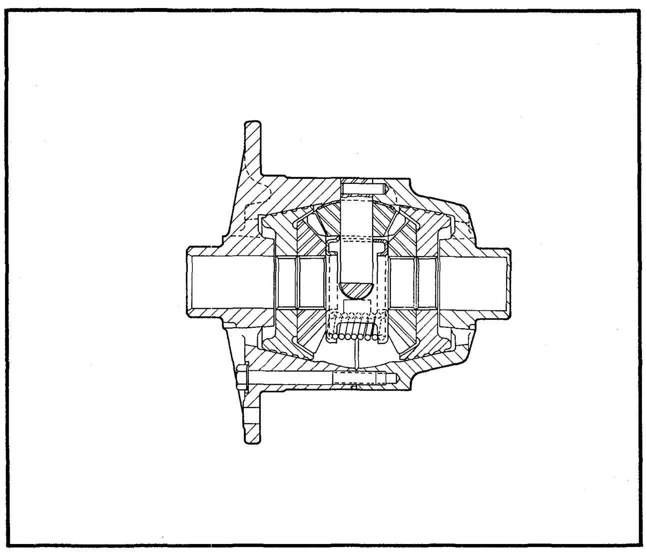


Fig. 4-46 Cross Section - Safe-T-Track

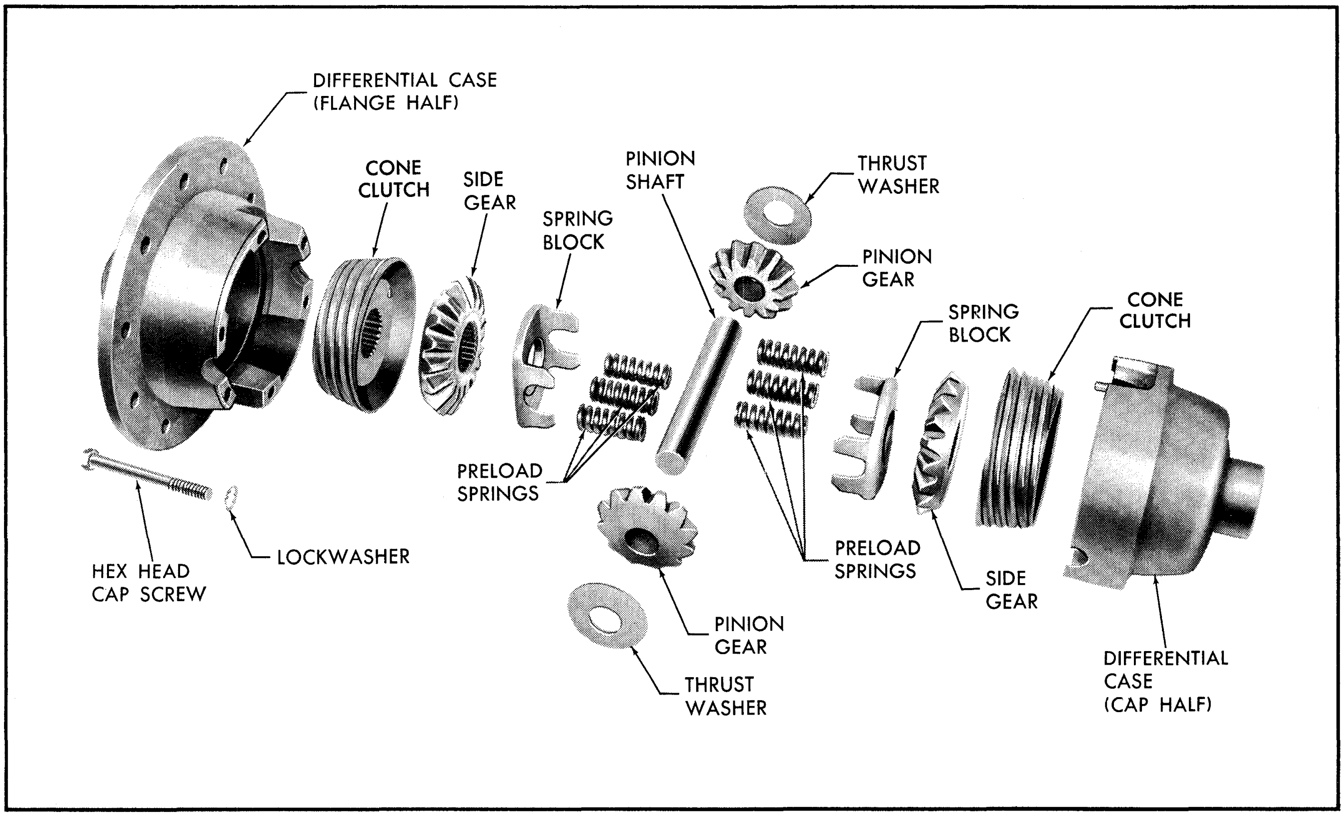



Fig. 4-47 Exploded View - Safe-T-Track

When the rear wheels are under extremely unbalanced tractive conditions, such as one wheel on dry pavement and the other on ice, wheel spin can occur if over acceleration is attempted. However, even when wheel spin does occur, the major driving force is directed to the non-spinning wheel.

*NOTE: Continued spinning may cause a whirring sound due to the overrunning clutch cones lacking sufficient lubricant. Such a condition or sound does not indicate failure of the unit.*

## SERVICE PROCEDURES

All rear axle service procedures are the same for the Safe-T-Track as for the conventional differential, except for servicing the case assembly.

*NOTE: Two precautions must be observed when working on cars with Safe-T-Track differentials:*

1. Never raise one wheel and run the engine with the transmission in gear. The driving force to the wheel on the floor may cause the car to move.

2. Do not use "on the car" type wheel balancers on the rear wheels, unless both wheels are off the floor.

### LUBRICATION

The differential should be checked for leaks and level every 6000 miles. Maintain level to bottom of the filler plug opening. No periodic lubricant change is recommended. However, if necessary to add lubricant, use only Multi-Purpose Hypoid Gear Lubricant (Part No. 531536).

*IMPORTANT: Never use any other lubricant in a Safe-T-Track differential or a severe chatter may result, especially when turning corners. If the wrong lubricant is added, remove it from housing, flush with clean engine oil and refill with the proper lubricant. It may be necessary to drive the car several miles to allow the lubricant to work through the cones and eliminate the chatter. If chatter persists drain and refill again to eliminate the contamination. Capacity of the rear axle housing is 3 pints.*

### TESTING FOR CORRECT OPERATION

If there is any doubt as to the proper functioning of the Safe-T-Track differential, the following simple test should be performed.

1. Place the car on a hoist with engine off and the transmission selector lever in park if automatic and in low gear if synchromesh.

2. Attempt to turn either wheel.

3. The average man will find it extremely difficult, if not impossible, to manually turn either wheel. This is because one wheel will provide approximately 400 lbs. draw bar pull with zero traction at the opposite wheel.

### SAFE-T-TRACK DIFFERENTIAL CASE ASSEMBLY—DISASSEMBLE

1. Before disassemblying differential case, inspect differential side bearings for visible damage of rollers and outer races.

2. Place one outer race onto its mated inner race and roller assembly and turn slowly, applying hand load.

3. If bearing outer race turns smoothly and no visible damage is found, bearing can probably be reused.

4. Repeat above operation with other outer race and mated bearing and check for smoothness.

*NOTE: Both side bearings and their outer races are mated parts. If either bearing is to be replaced, its mating outer race must also be replaced.*

5. Inspect fit of inner races on case hubs by prying against shoulders at puller recesses. Bearing inner races must be tight on case hubs.

*NOTE: If either bearing is loose on case, the entire case must be replaced.*

6. If bearing inspection indicates that bearings should be replaced, insert differential case in vise and, using side bearing puller J-986-P and adapter J-8107 remove side bearing.

*CAUTION: Make certain ends of puller arms are firmly seated in recesses in sides of hubs and fully against inner race of bearing.*

7. Turn differential case in vise and remove other side bearing in same manner.

8. If ring gear is to be removed, clamp case in vise so jaws are 90° to pinion shaft holes and remove ten ring gear retaining bolts.

9. Partially re-install two bolts on opposite sides of ring gear.

10. Remove ring gear from case by alternately tapping on bolts.

*CAUTION: Do not pry between case and ring gear.*

11. Scribe mark or paint differential case halves (Fig. 4-48) to aid in alignment of case when assembling.

12. Remove six differential case attaching bolts.

13. Lift cap half of case from flange half. Remove clutch cone side gear, thrust block, preload springs and shims if provided.

*NOTE: Shims are used in some units between the side gear and cone to maintain proper backlash between pinion gears and side gears. Keep these parts with the cap half of case assembly.*

14. Remove corresponding parts from flange half of case and keep with flange half of case assembly.

### CLEANING AND INSPECTION OF PARTS

1. Make certain all parts are absolutely clean and dry.

2. Inspect pinion shaft, pinion and side gears, brake cone surfaces and corresponding cone seats in the case. The cone seats in the case should be smooth and free of any excessive scoring. Slight grooves or scratches indicating passage of foreign

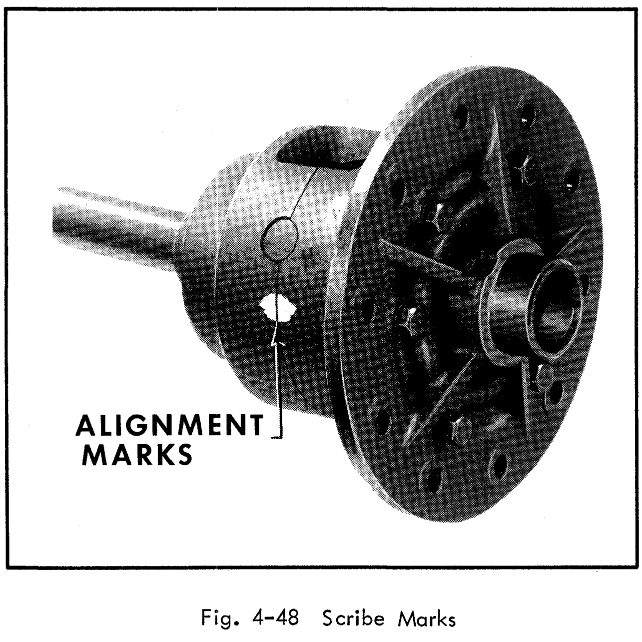



Fig. 4-48 Scribe Marks

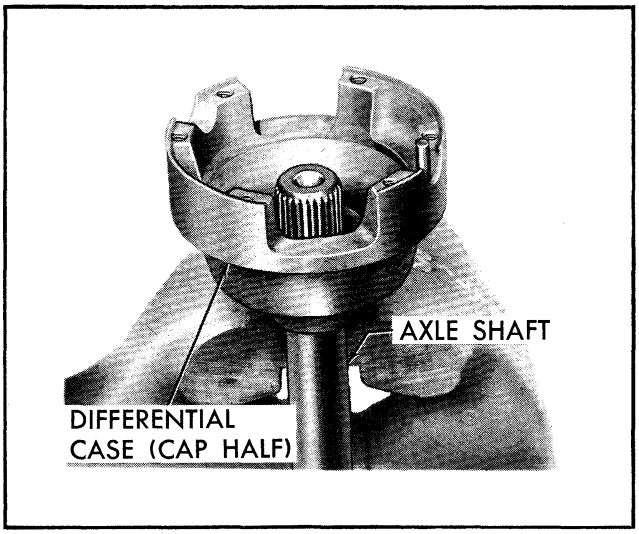



Fig. 4-49 Axle Shaft and Cap Half of Case in Vice

material are permissible and normal. The land surface on the heavy spirals of the male cones will duplicate the case surface condition. Replace any parts which are excessively scored, pitted or worn. Both halves of case must be replaced if one half is damaged or worn.

## SAFE-T-TRACK DIFFERENTIAL—ASSEMBLE

*CAUTION: When assembling the unit, use axle shafts as mounting tools to assure proper gear and cone spline alignment. Do not ignore this procedure as it will be impossible to install shafts at final assembly and attempting to force the shafts into position may result in damage to the spring thrust blocks.*

1. Clamp one axle shaft in a vise allowing three inches to extend above vise jaws. Then place the cap side of differential case over extended axle shaft with interior of case facing up. Fig. 4-49.

2. Install proper cone over axle shaft splines, seating it into position in cap half of case.

*NOTE: Be certain that each cone is installed in proper case half since tapers and surfaces become matched and their positions should not be changed.*

3. If unit was originally assembled with shims located between side gears and cones for backlash adjustment, reinstall side gear with shim so that gear may seat on shim. If unit was originally assembled without shims, reassemble the same way.

4. Place one spring block in position over gear face in alignment with pinion gear shaft grooves.

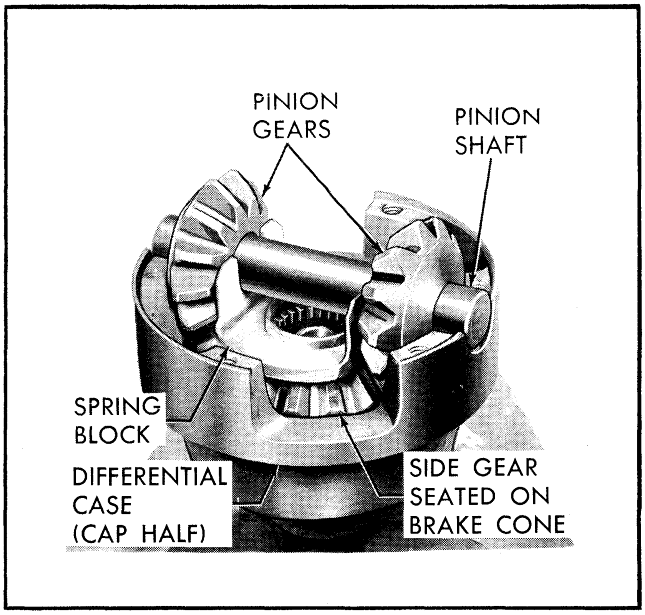



Fig. 4-50 Installing Parts in Cap Half

Install thrust block, pinion shaft, pinion gears and thrust washers into cap half of differential case in such a manner that pinion shaft retaining dowel can be inserted through pinion gear shaft into differential case. This prevents the pinion shaft from sliding out and causing damage to carrier assembly. Fig. 4-50.

5. Insert springs into spring thrust block that is already installed into case and then place second thrust block over springs. Note offset construction of thrust block tabs. Fig. 4-51.

6. Install second side gear face down on spring thrust block so that side gear will mesh with pinion gears.

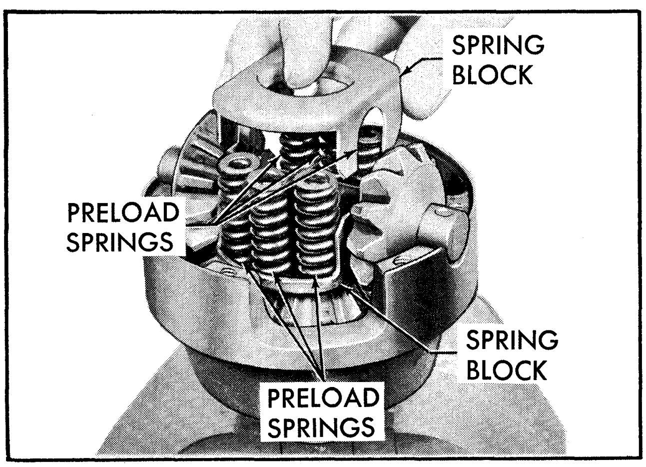



Fig. 4-51 Installing Second Thrust Block

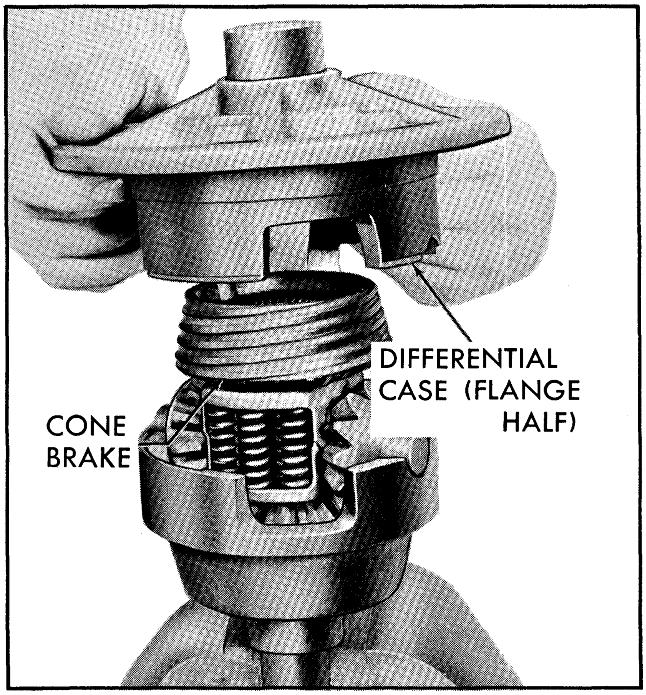



Fig. 4-52 Installing Flange Half of Differential Case

7. Place shim, if provided, and remaining cone over side gear.

8. Install flange side of differential assembly over cone in proper position to match alignment marks; insert two bolts finger tight 180° apart. Fig. 4-52.

9. Install other axle shaft through flange half of differential case rotating axle to enter cone splines and then side gear splines. Leaving the axle shaft in this position, insert remaining bolts and tighten to 15-18 ft. lb. See Fig. 4-53.

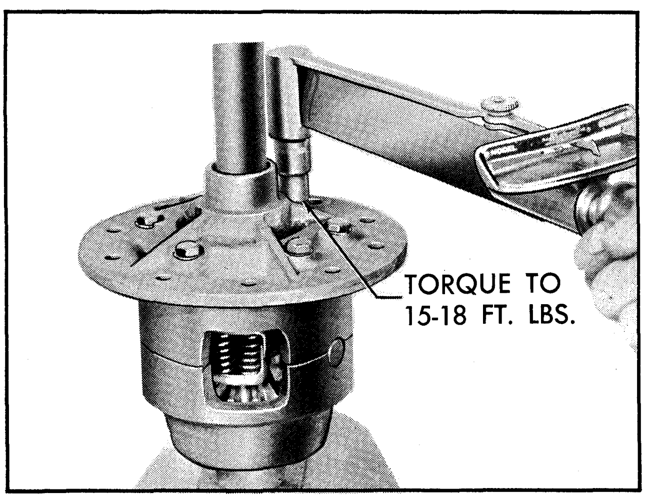



Fig. 4-53 Torquing Case Half Bolts

10. Remove axle shafts. A slight taping on the shafts with a soft hammer may be necessary to align the splines during assembly. The shafts can then be readily reinstalled without spline interference during final assembly.

11. If side bearings were removed, lubricate outer bearing surfaces and press on bearings as described in (standard) differential case assembly - assemble.

12. After making sure that mating surfaces are clean and free of burrs, position ring gear on case so holes are in line.

13. Lubricate attaching bolts with clean engine oil and install.

14. Pull ring gear onto case by alternately tightening bolts around case. When all bolts are snug, tighten bolts evenly and alternately across diameter to 55-65 lb. ft. torque.

*CAUTION: Do not use hammer to force ring gear on case.*

15. Install unit into axle carrier following instructions given for Standard Differential.

*CAUTION: After unit is installed in carrier, do not attempt to rotate on axle shaft unitl both are in position. Rotation of one shaft without the other installed will result in misalignment of cone and side gear splines and may prevent entry of second shaft.*

## TROUBLE DIAGNOSIS AND TESTING

Many noises reported as coming from the rear axle actually originate from other sources such as tires, road surfaces, wheel bearings, engine, transmission, muffler, body drumming, etc. A thorough and careful check should be made to determine the source of the noise before disassembling the differential. Noise which originates in other places cannot be corrected by adjustment or replacement of parts in the rear axle. It should also be remembered that differential gears, like any other mechanical device, are not absolutely quiet and should be accepted as being commercially quiet unless some abnormal noise is present.

To make a systematic check for axle noise under standard conditions observe the following:

1. Select a level tarvia or asphalt road to reduce tire noise and body drumming.

2. Drive car far enough to thoroughly warm up rear axle lubricant.

3. Note speed at which noise occurs. Then stop car and with clutch disengaged or automatic transmission in neutral, run engine slowly up and down through engine speeds corresponding to car speed at which noise was most pronounced to determine if it is caused by exhaust, muffler roar or other engine condition. Repeat while engaging and disengaging clutch (transmission in neutral) to determine if noise is in transmission. (Transmission rear bearing noise can only be isolated by removing propeller shaft and operating transmission in "high".)

4. Tire noise changes with different road surfaces, but rear axle noise does not. Temporarily inflating all tires to approximately 50 pounds pressure, (for test purposes only) will materially alter noise caused by tires, but will not affect noise caused by rear axle. Rear axle noise usually ceases when coasting at speeds under 30 miles per hour; however, tire noise continues but with lower tone as car speed is reduced. Rear axle noise usually changes when comparing "pull" and "coast", but tire noise remains about the same.

Distinguish between tire noise and differential noise by noting if noise varies with various speeds, sudden acceleration and deceleration; exhaust and axle noise show variations under these conditions while tire noise remains constant and is more pronounced at speeds of 20 to 30 miles per hour. further check for tire noise by driving car over smooth pavements or dirt roads (not gravel) with tires at normal pressure. If noise is caused by tires, it will noticeably change or disappear and reappear with changes in road surface.

5. Loose or rough front wheel bearings will cause noise which may be confused with rear axle noises; however, front wheel bearing noise does not change when comparing "pull" and "coast". Light application of brake while holding car speed steady will often cause wheel bearing noise to diminish as this takes some weight off the bearing. Front wheel bearings may be easily checked for noise by jacking up the wheels and spinning them, also by shaking wheels to determine if bearings are loose.

6. Rear suspension rubber bushings and coil spring insulators dampen out rear axle noise when correctly installed. Check to see that no metallic contact exists between the springs and spring opening in frame or between upper and lower control arm bushings and frame or axle housing brackets. Metal-to-metal contact at those points may result in "telegraphing" road noise and normal axle noise which would not be objectionable if dampened by bushings.

*NOTE: It is important that a check also be made to ensure that the floor of body is not in metallic contact with frame.*

### AXLE NOISES

#### GEAR NOISE

After the noise has been determined as being in the axle by following the above appraisal procedure, the type of axle noise should be determined to aid in making repairs if necessary.

Gear noise (whine) is audible from 20 to 65 MPH under four driving conditions.

1. Drive - Acceleration or heavy pull.

2. Road Load - Car driving load or constant speed.

3. Float - Using enough throttle to keep the car from driving the engine - car slows down gradually but engine still pulls slightly.

4. Coast - Throttle closed and car in gear.

Gear noise most frequently has periods where noise is more prominent, usually 30 to 40 MPH and 50 to 60 MPH.

When objectionable axle noise is encountered, the driving condition and speed range should be noted and then differential removed for a red lead check. Shim and adjust to obtain best possible tooth pattern. If noise still persists, replace gear set.

#### BEARING NOISE

Bad bearings generally produce more of a rough growl or grating sound rather than the whine typical of gear noise. Bearing noise frequently "wow-wows" at bearing rpm which indicates a pinion or differential side bearing.

*NOTE: This noise could easily be confused with rear wheel bearing noise. Inspect and replace as required. A preponderance of axle noise is gears rather than bearings.*

REAR WHEEL BEARING NOISE

A rough rear wheel bearing produces a vibration or growl which continues with car coasting and transmission in neutral. A brinelled rear wheel bearing causes a knock or click approximately every two revolutions of rear wheel, since the bearing rollers do not travel at the same speed as the rear axle and wheel. With rear wheels jacked up, spin rear wheels by hand while listening at hubs for evidence of rough or brinelled wheel bearing.

BEARING FAILURE

Bearings fail by "lapping", "spalling" or "locking".

LAPPING Lapping is caused by fine particles of abrasive material such as scale, sand or emery which are circulated by oil and which cause wearing away of roller and race surfaces. Bearings which are worn loose but remain smooth without spalling or pitting are clear evidence of dirty oil.

SPALLING Spalling failure of bearings is caused by overload or faulty assembly. Bearings which failed by spalling have either flaked or pitted rollers or races. Faulty assembly consists of misalignment or cocking of bearings, or adjustments which are too tight.

LOCKING Locking of bearings is caused by large particles of foreign material becoming wedged between rollers and race usually causing one of the races to turn. Preloading of taper roller bearings higher than specified can also cause locking of bearings.

KNOCK AT LOW SPEEDS

Low speed knock can be caused by worn and brinelled universal joints or a side gear hub counterbore in case worn oversize. Inspect and replace universal joint or case and side gear as required.

DRIVE-LINE SNAP

A snap sudden start either forward or reverse may be caused by loose companion flange. Remove flange, turn 180°, apply white lead and oil to spline and reinstall. Pinion nut must be tightened to original position.

BACKLASH CLUNK

Excessive clunk with acceleration and deceleration is caused by worn differential pinion shaft, excessive clearance between axle shaft and side gear splines, excessive clearance between side gear hub and counterbore in case, worn pinion and side gear teeth, worn thrust washers and excessive drive pinion and ring gear backlash. Remove worn parts and replace as required selecting close fitting parts when possible. Adjust pinion and ring gear backlash.

DRIVE-LINE SQUEAL AND SQUEAK

Squeals and squeaks are audible only at low speeds, seldom over 20 MPH. A continuous squeal is from the pinion oil seal and an intermittent squeak is caused by dry cork washer in the universal joint. Seal squeaks frequently correct themselves but replace persistent squealing seal. Universal joint cork washers should be replaced and lubricated.

PROPELLER SHAFT VIBRATION

Objectional vibrations at high speed (65 MPH or higher) may be caused by a propeller shaft that is out of balance. Out of balance may be due to a bent shaft.

To determine whether propeller shaft is causing vibration, drive car through speed range and note speed at which vibration is most pronounced. Shift transmission into lower gear range, and drive car at same engine speed as when vibration was most pronounced in direct drive. Note effect on vibration.

To determine engine speed, divide vehicle speed by the following transmission gear ratios as listed below:

1.68 (3 speed s-m in second gear)
1.48 (4 speed s-m in third gear)
1.76 (automatic transmission in low range)

EXAMPLE: If vibration is most pronounced in direct drive at 65 MPH, the same engine speed would be produced

in second gear (3 speed s-m) at
65/1.68 = 39 MPH;

in third gear (4 speed s-m) at
65/1.48 = 44 MPH;

in low range (automatic) at
65/1.76 = 37 MPH.

If the vibration is still present at the same engine speed whether in direct drive or in the lower gear, since the propeller shaft speed varies, this cannot be the fault. If the vibration decreases or is eliminated in the lower gear, then the propeller shaft is out of balance and should be rebalanced or replaced.

See Section 4A (Propeller Shaft) for further trouble diagnosis.

### OIL LEAKS

It is difficult to determine the source of some oil leaks. When there is evidence of an oil leak these locations, the probable cause is as follows:

Oil coming from between the rear pinion flange slinger and the carrier is caused by a leaking pinion seal.

Even after the point of leakage has been determined, it is hard to tell whether the oil is leaking past the lip of the seal or past the O.D. of the seal. Therefore, it is a good idea to make sure the leak is stopped by using a nonhardening sealing compound around the O.D. of the new seal.

## SPECIFICATIONS

### REAR AXLE

| | |
|---|---|
| Type | Semi-Floating |
| Type of Drive | Modified Hotchkiss |
| Drive - Final | Hypoid Gear |
| Lubricant Capacity | 48 oz. or 3 pints |
| Lubricant | Multi-Purpose Hypoid Gear Lubricant |
| Lubricant Level | Bottom of Filler Plug Hole |

### RING AND PINION GEAR

| | |
|---|---|
| Backlash | .005" - .009" |
| Ring gear run-out maximum | .002" |
| Ratios | See Fig. 4-4 |
| Pinion Bearing Preload | |
| New Bearings (New Seal) | 20-30 lb. in. |
| Old Bearings (New Seal) | 12-20 lb. in. |
| Side Bearing Preload (At Ring Gear With Pinion) | |
| New Bearings | 30-40 lb. in. |
| Old Bearings | 20-30 lb. in. |

## TORQUE SPECIFICATIONS

| | Lb. Ft. |
|---|---|
| Differential Cover to Carrier Bolts | 20-30 |
| Differential Bearing Caps to Carrier Bolts | 60-75 |
| Differential Ring Gear to Case Bolts | 55-65 |
| Differential Pinion Shaft Lock Screw | 10-20 |
| Rear U-Joint Companion Flange Nut | 14-20 |
| Rear Axle Upper Control Arm Assy to Axle Housing Bolt | 75-100 |
| Rear Axle Upper Control Arm Assy to Axle Housing Nut | 60-85 |
| Rear Axle Lower Control Arm Assy to Axle Housing Bolt | 75-100 |
| Rear Axle Lower Control Arm Assy to Axle Housing Nut | 60-85 |
| Rear Axle Upper Control Arm Assy to Frame Bolt | 75-100 |
| Rear Axle Upper Control Arm Assy to Frame Nut | 60-85 |
| Rear Axle Lower Control Arm Assy to Frame Bolt | 75-100 |
| Rear Axle Lower Control Arm Assy to Frame Nut | 60-85 |
| Rear Axle Bumper Spacer to Axle Housing Bracket Bolt and Nut | 40-55 |
| Rear Spring Lower Clamp to Axle Housing Seat Bolt & Nut | 30-40 |
| Rear Shock Absorber to Axle Housing Bracket Nut | 55-75 |
| Shock Absorber to Frame Bolt and Nut | 15-25 |
| Rear Wheel and Drum to Axle Shaft Nut | 70-85 |
| Rear Brake Assy to Axle Housing Bolt and Nut | 40-55 |
| Differential Case Bolts (Safe-T-Track) | 15-18 |

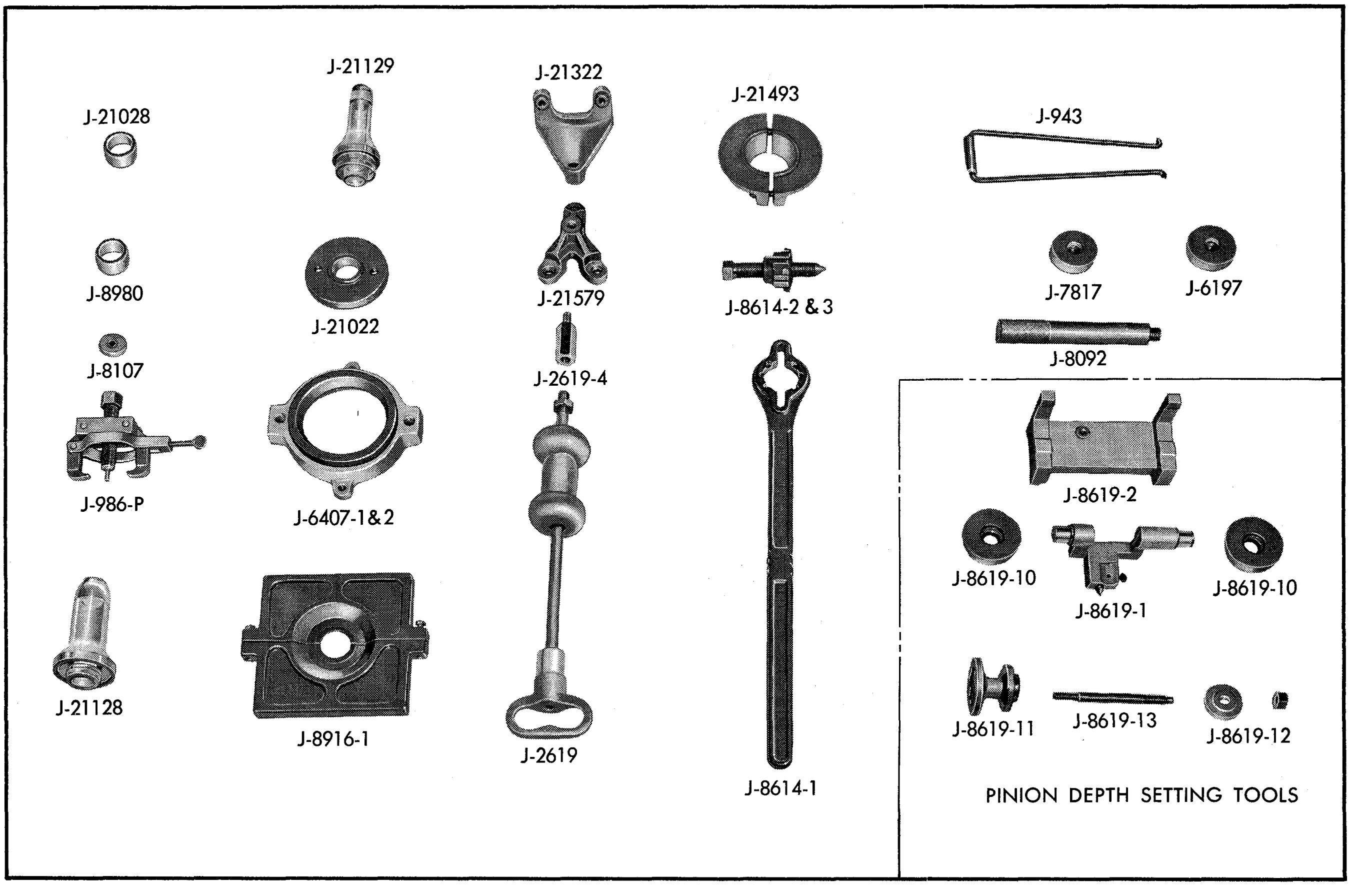



Fig. 4-54 Tools

| | |
|---|---|
| J-943 | Oil Seal Remover |
| J-986-P | Differential Side Bearing Puller |
| J-2619 | Slide Hammer |
| J-2619-4 | Adapter |
| J-6197 | Rear Pinion Bearing Outer Race Installer |
| J-6407-1 & 2 | Press Plate Holder and Insert |
| J-7817 | Front Pinion Bearing Outer Race Installer |
| J-8092 | Drive Handle |
| J-8107 | Adapter |
| J-8614-1 | Companion Flange Holding Tool |
| J-8614-2 & 3 | "U" Joint Companion Flange Puller |
| J-8619-1 | Pinion Depth Gauge Indicator |
| J-8619-2 | Pinion Depth Master Gauge |
| J-8619-10 | Pinion Depth Gauge Discs |
| J-8619-11 | Pinion Depth Gauge Plate |
| J-8619-12 | Pinion Depth Gauge Pilot |
| J-8619-13 | Pinion Depth Gauge Bolt and Nut |
| J-8916-1 | Split Plate |
| J-8980 | Differential Side Bearing Installer |
| J-21022 | Axle Shaft Bearing Installer |
| J-21028 | Differential Side Bearing Installer |
| J-21128 | Pinion Oil Seal Installer |
| J-21129 | Axle Shaft Oil Seal Installer |
| J-21322 | Differential Case Remover |
| J-21493 | Rear Pinion Bearing Remover |
| J-21579 | Axle Shaft Remover |

# PROPELLER SHAFT

CONTENTS OF THIS SECTION



## GENERAL DESCRIPTION

The propeller shaft is the connecting link between and transmits power from the transmission to the differential. Two shafts are used; a solid tubular steel shaft on cars equipped with a synchromesh transmission, and one incorporating rubber torsional dampeners on cars equipped with an automatic transmission Fig. 4A-1.

Each shaft has a universal joint and a splined yoke on the transmission end and are held in alignment by a bushing in the transmission rear bearing retainer (or rear extension housing), and a universal joint at the differential end (Fig. 4A-2).

A U-bolt type clamp and locking plate is used to attach the universal joint to the companion flange at the differential. The front joint attaches to the output shaft of the transmission by means of a splined yoke which permits fore and aft movement of the propeller shaft when the rear axle assembly moves up and down. This splined connection is lubricated from the transmission. An oil seal pressed into the transmission rear bearing retainer protects the transmission yoke from dust as well as loss of transmission lubricant.

## INSPECTION

No periodic inspection of the propeller shaft assembly is required. Since the propeller shaft assembly is a balanced unit, it should be kept free of undercoating and other foreign material which could upset shaft balance.

## MINOR SERVICES AND REPAIRS

### *ALIGNMENT OF ENGINE AND PROPELLER SHAFT*

Adjustment of the propeller shaft angle, such as shimming cannot be made at the rear axle and is not required at the front (engine and transmission).

All necessary differential pinion angle requirements are designed and built into the rear upper and lower control arm geometry. Slots in the engine front motor mounts provide for fore and aft movement of the engine and transmission assembly to give allowance for variation of the positioning of the transmission rear cross member. The relationship of engine crankshaft angle to propeller shaft angle is maintained within specification by design.

## MAJOR REPAIRS

### *REMOVE PROPELLER SHAFT DRIVE LINE ASSEMBLY*

1. Remove U-bolt nuts, lock plates and U-bolts from rear axle drive pinion flange.

2. Use a suitable rubber band to hold bearing onto journals if tie wire has been removed to prevent loss of needle bearings when rear joint is disconnected (Fig. 4A-3).

3. Remove complete drive line assembly by sliding rearward to disengage from splines on transmission main shaft.

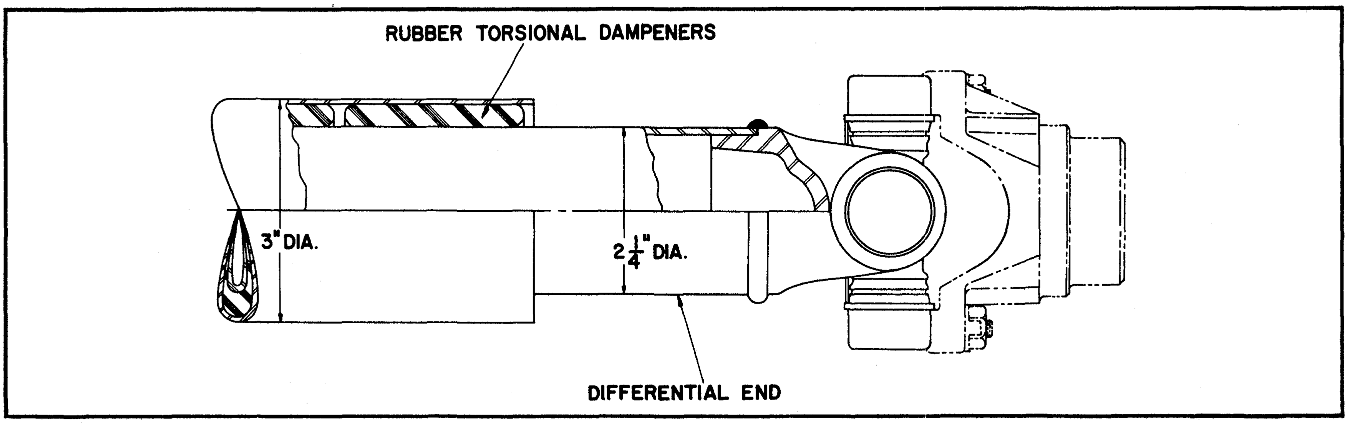



Fig. 4A-1 Insulated Propeller Shaft

### DISASSEMBLE PROPELLER SHAFT UNIVERSAL JOINTS

*NOTE: When removing bearings from universal joint yokes, use extreme care so as not to lose needle rollers from bearings.*

1. Remove snap ring from yoke members by using screwdriver or similar tool.

2. Remove bearings from splined yoke member as follows:

a. Lay or clamp end of shaft in vise so fixed yoke member welded to tube bears against vise. (Do not lay or clamp tubular member in vise.) Shaft should be horizontal and splined yoke member must be free to move vertically between jaws of vise.

b. Using a piece of pipe or similar tool with diameter sufficiently large to encircle bearing (slightly larger than 1-1/8 inch), apply force on yoke around bearing (Fig. 4A-4). This will drive yoke down causing journal assembly (spider) to force bearing partially out of yoke.

c. Rotate shaft 180° and repeat above step to partially remove opposite bearing.

d. With yoke down as far as possible, place one or more flat washers (9/16" O.D.) inside lower bearing (Fig. 4A-5).

*NOTE: Total thickness of washers should be 1/8"-3/16".*

e. Rotate shaft 180° and again apply force around bearing in which washers were installed. This will completely remove bearing from yoke.

f. Remove splined yoke member from journal.

g. Remove remaining bearing from splined yoke member using brass drift.

3. Remove bearings and journal (spider) from fixed yoke member, which is welded to tubular shaft, as follows:

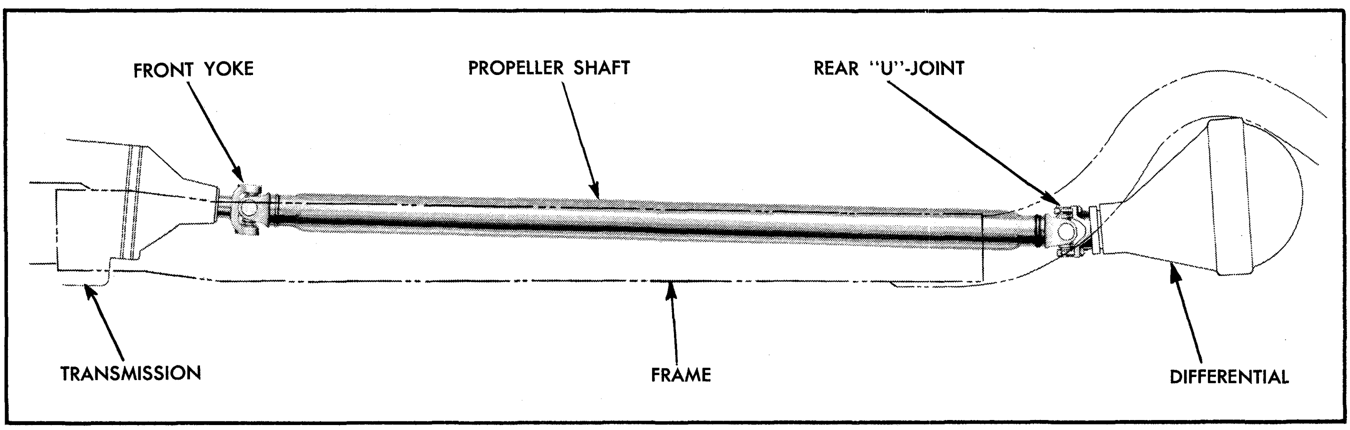



Fig. 4A-2 Relationship of Propeller Shaft to Transmission, Differential and Frame

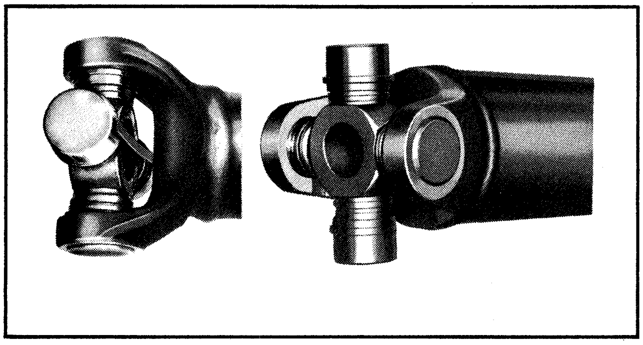


Fig. 4A-3 Bearings Held in Place by Tie Wire

a. With yoke member clamped or supported in vise, drive bearing out as far as possible using drift applied to center part of journal (Fig. 4A-6).

b. Rotate shaft 180° and drive opposite bearing out as far as possible using drift in same manner as in above step.

c. Hold journal up and install three or four small flat washers (Fig. 4A-7). Lower journal onto washers and drive bearing out using drift applied to journal.

d. Remove journal from yoke.

e. Remove remaining bearing using brass drift.

### *CLEANING AND INSPECTION*

1. Wash all parts thoroughly in a cleaning fluid. Probe holes in journals to remove any hardened grease.

2. Inspect roller bearing surfaces of journals, inner bearing surfaces of outer races, and rollers for wear, scores, flat spot or other damage.

3. Inspect packings (cork washers) and journal dust shields for wear and injury. Replace if necessary. Packing should be flexible, if brittle or hard replace with new packing.

4. Inspect outer surface of propeller shaft splined yoke to ensure that it is not burred since burrs will damage seal. Also inspect splines for freedom from dirt.

### *ASSEMBLE PROPELLER SHAFT*

1. Repack roller bearings and fill holes in ends of journal with high melting point wheel bearing lubricant (18 rollers are used for each bearing).

2. Install bearing journal and bearings in fixed yoke member as follows:

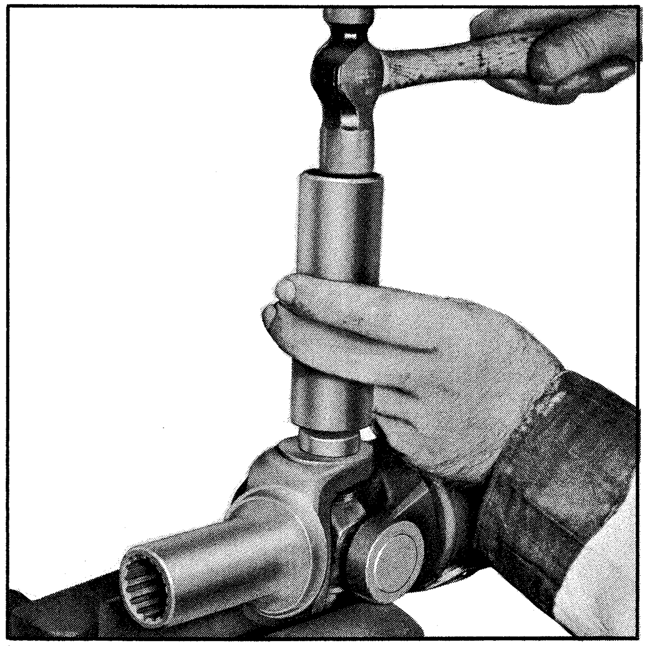


Fig. 4A-4 Removing Bearing From Splined Yoke Member

a. Press cork washer into position in recess of bearing and install bearing about one quarter way in on one side of fixed yoke using soft faced hammer.

b. Position journal, with dust shields installed, between arms of yoke and place journal in partially installed bearing.

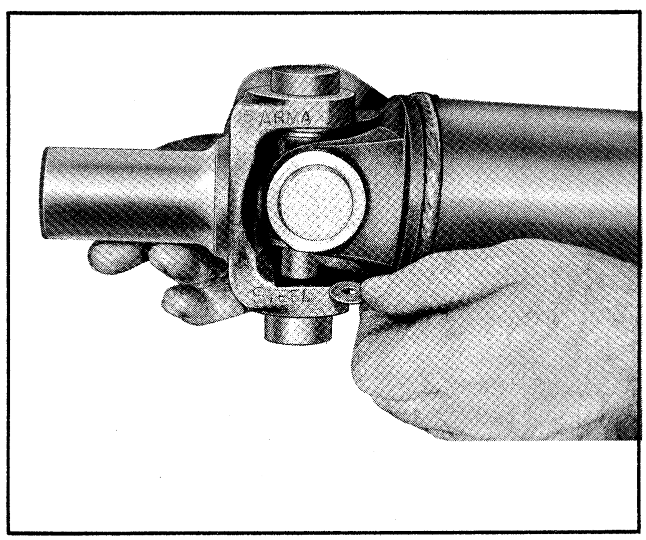


Fig. 4A-5 Placing Washers Inside Bearing of Splined Yoke Member

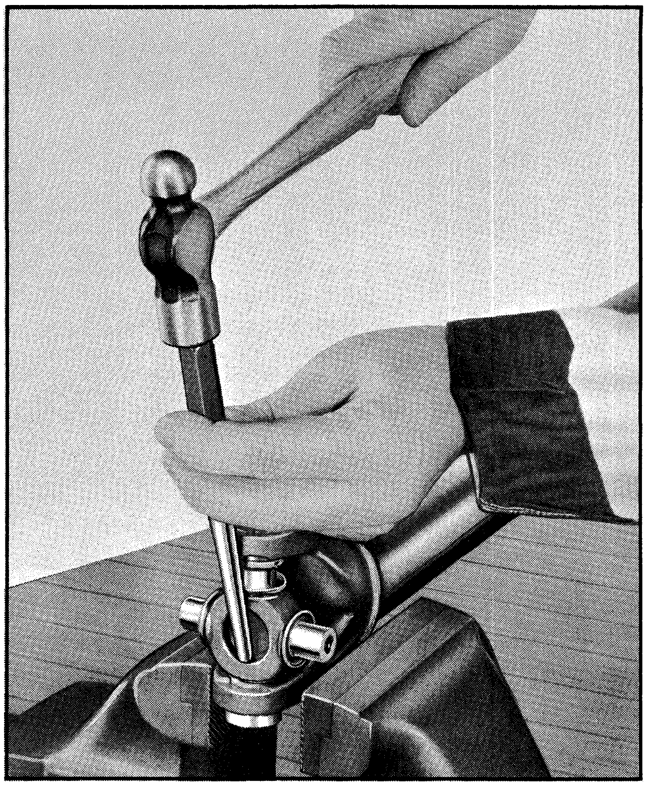


Fig. 4A-6 Removing Bearing From Fixed Yoke Member

c. Hold journal in place and complete installing bearing.

d. Install opposite bearing, with cork washer in place, ensuring that bearing rollers do not bind on journal. Check movement of journal in bearings for smoothness.

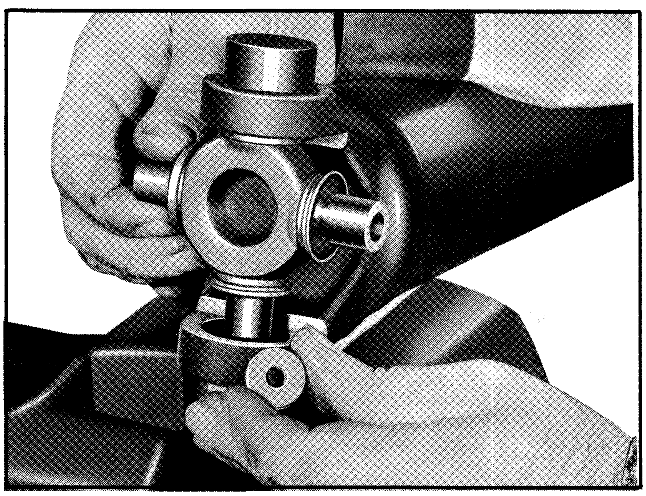


Fig. 4A-7 Placing Washers Inside Bearing of Fixed Yoke Member

*NOTE: It may be necessary to tap fixed yoke with hammer to free joints of bind.*

3. Install bearings in splined yoke member as follows:

a. Press cork washer into bearing and start bearing into place in splined yoke member with a soft faced hammer.

b. Position yoke over journal so arm of journal seats in bearing. Support yoke on opposite side and complete installation of bearing.

c. Press cork washer in place in remaining bearing and install bearing, ensuring that bearing rollers do not jam on journal. Check for free movement of universal joint.

4. Install snap rings in yoke members with gap toward yoke.

## INSTALL PROPELLER SHAFT DRIVE LINE ASSEMBLY

1. Inspect outer diameter of splined yoke to ensure that it is not burred so as to damage transmission seal.

2. Apply engine oil to spline and outside diameter of yoke and slide propeller shaft front joints onto transmission output shaft.

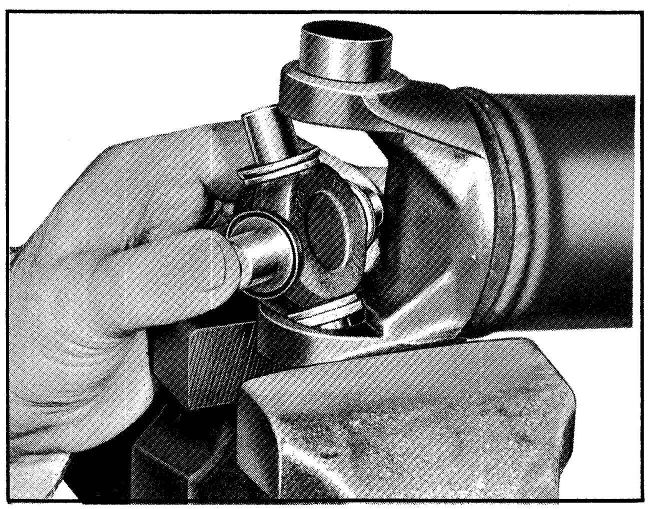


Fig. 4A-8 Correct Installation of Journal to Yoke

3. Position rear universal joint to rear axle companion flange making sure trunnion bearings are properly aligned in companion flange yoke.

4. Install U-bolts, lock plates and nuts and tighten U-bolt nuts to 14-20 lb. ft. torque. Ensure that ears of lock plates are bent up against flat side of nuts.

## TROUBLE DIAGNOSIS AND TESTING

### *OIL LEAK AT FRONT YOKE*

| CAUSE | REMEDY |
|---|---|
| Rough outside surface on splined yoke or defective transmission rear oil seal. An occasional drop of oil dripping from the spline yoke is normal and requires no correction. | Replace seal if cut by burrs on yoke. Replace yoke if outside surface is rough and burred badly. Minor burrs can be smoothed by careful use of crocus cloth or honing with a fine stone. |

### *KNOCK IN DRIVE LINE*

| CAUSE | REMEDY |
|---|---|
| Worn universal joints.<br>*NOTE: "Clunking" noise when car is operated under "floating" condition at approximately 10 mph in high gear or neutral.* | Disassemble universal joints, inspect and replace worn parts. |

### *PROPELLER SHAFT VIBRATION*

If vibration comes in at definite speed while car is moving, check by driving car at speed above which vibration came in, shutting off engine and coasting in neutral down through speed where vibration came in. If vibration comes in at same speed when coasting, it is probably caused by propeller shaft or tires.

Tires may give a vibration at certain high speeds which could be mistaken for propeller shaft vibration. By inflating tires above normal pressure and retesting, it may be possible to distinguish tire noise from propeller shaft vibration. When it has been established that the tires are not the cause of vibration, then check propeller shaft assembly for balance and replace shaft.

## WRENCH TORQUE SPECIFICATIONS

(Torque in lb. ft.)

| TORQUE | SIZE | APPLICATION |
|---|---|---|
| 14-20 | 5/16-24 | Nut, Rear Universal Joint Companion Flange Clamp |

# BRAKES

## CONTENTS OF THIS SECTION



## GENERAL DESCRIPTION (Fig. 5-1)

All Tempest models are equipped with duo-servo self-adjusting hydraulic brakes.

The brake pedal is suspended from a bracket attached to the instrument panel and dash. The pedal pivots in nylon bushings at the pivot shaft.

The brake master cylinder is attached to the engine side of the dash. A push rod connects the brake pedal to the master cylinder.

The brake light switch is mounted on the brake pedal mounting bracket (Fig. 5-1).

### *DRUMS*

More effective brake cooling has been achieved with 9 1/2" brake drums. They are much wider and heavier for increased performance and are located well into the air stream for excellent heat dissipation.

The front drums are centrifugally cast iron in a corrugated steel shell while the rears are statically cast iron with 40 axle ribs around the outside. Both front and rear drums have cooling flanges that extend beyond the backing plate for improved cooling.

### *BACKING PLATES*

Efficient water sealing has been achieved through the use of special shields welded to the backing plates.

### *LININGS*

Thicker secondary linings have resulted in increased service life. The longer primary linings improve performance and increase the brake effectiveness.

### *PARKING BRAKES*

The parking brake lever (Fig. 5-2) operates the rear brakes through a system of cables. This brake is foot operated and the actuating lever is mounted under the left side of the instrument panel.

## OPERATION

### *BRAKE MECHANISM*

The self-adjusting brake mechanism operates only when brakes are applied while car is moving rearward. This action causes the secondary shoe to move a pre-determined distance toward the brake drum providing the brake linings are worn enough to allow this movement.

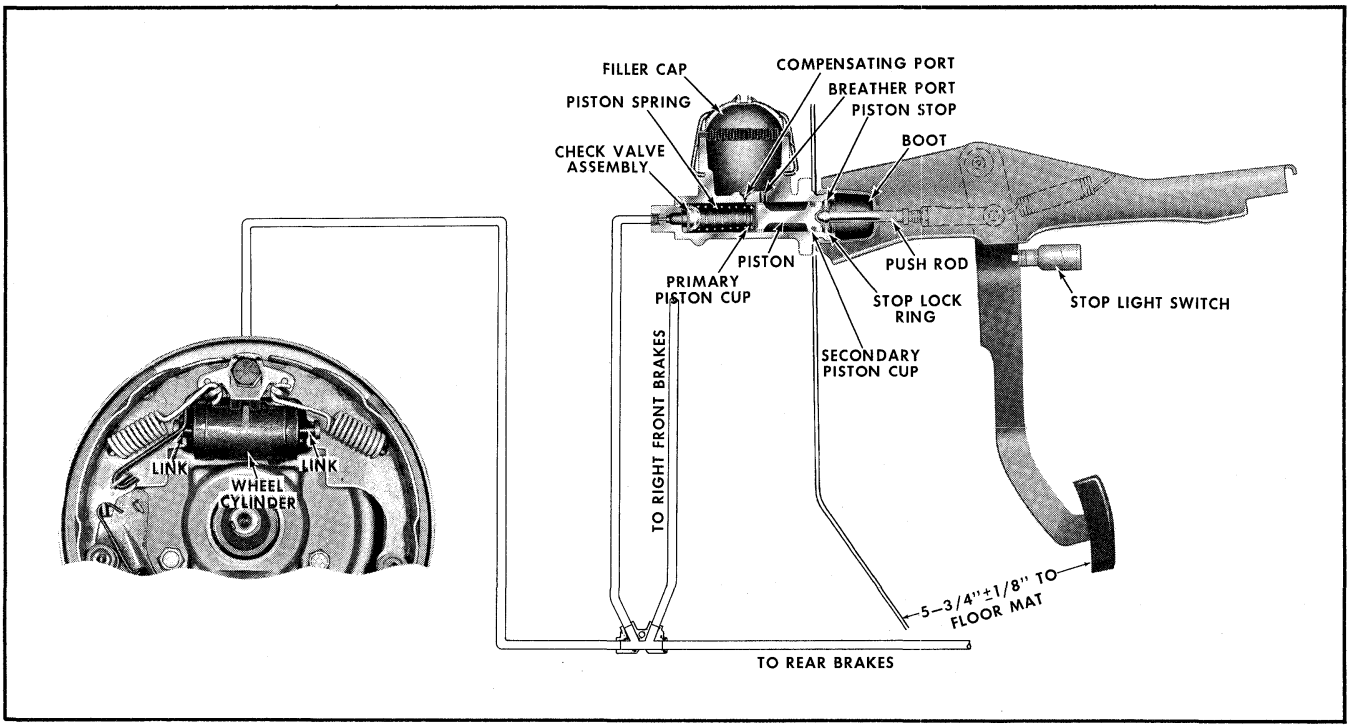



Fig. 5-1 Schematic Diagram of Hydraulic System

As car moves in reverse and brakes are applied, friction develops between the primary (or front) shoe and the drum. This friction forces the primary shoe against the anchor pin. At the same time, hydraulic pressure in the wheel cylinder forces the upper end of the secondary (or rear) shoe away from the anchor pin. As the secondary shoe moves away from the anchor pin, the upper end of the adjuster lever is prevented from moving by the actuating link which is attached to the anchor pin. Since the adjuster lever pivots on the secondary shoe, the above movement forces the lower end of the adjuster lever against the adjusting screw star wheel.

If the brake linings are worn enough to allow the secondary shoe to move a pre-determined distance, the adjuster lever will turn the adjusting screw star wheel one or two teeth, depending on amount of lining wear. If the secondary shoe does not move the pre-determined distance, adjuster lever movement will not be enough to rotate the adjusting screw star wheel.

When brakes are released, the actuating lever return spring will reposition the actuating lever into the adjusting position at the adjusting screw star wheel.

An override feature is incorporated into the self-adjusting brake which in the event the adjusting screw is "frozen", prevents the self-adjuster from operating.

When the car is moving forward and brakes are applied, the upper end of the secondary shoe is forced against the anchor pin because of the self-energizing action of the brakes, and the self-adjuster does not operate.

### HYDRAULIC SYSTEM

Depressing the brake pedal moves the master cylinder push rod and piston, forcing hydraulic fluid out through a check valve (Fig. 5-1). This fluid flows through the hydraulic lines into the wheel cylinders, forcing the wheel cylinder pistons outward from the center of the cylinder and expanding the brake shoes and linings against the brake drums.

When the brake pedal is released quickly, the master cylinder piston returns to the released position faster than fluid returns from the lines. Holes in the piston head allow fluid to pass from the rear to front of the piston head, past the primary cup to fill in this space.

At the same time (when the pedal is released) the brake shoe return springs force the wheel cylinder pistons to return toward the center of the wheel cylinder (released position). Fluid forced out of the

wheel cylinders by this action returns to the master cylinder by overcoming the pressure of the master cylinder piston spring which holds the check valve closed. As this fluid returns, the excess portion will return to the reservoir through the compensating port which must be uncovered when the master cylinder piston is in the released position. The piston spring will close the check valve when the pressure in the lines is reduced to 8-12 pounds per square inch, maintaining a slight pressure in the lines at all times. The purpose of this pressure is to keep wheel cylinder cups from leaking fluid and to reduce the possibility of air entering the system.

#### *PARKING BRAKES*

When the parking brake lever is depressed the lever pulls tight the cables connected to the rear brakes.

Each cable attaches to a rear brake actuating lever which pivots at a hole in the secondary shoe web. When the bottom of the lever is moved forward by the brake cable, the top of the lever engages the secondary shoe and forces it against the brake drum. At the same time the actuating lever forces the primary (front) to contact the brake drum by means of a strut between the actuating lever and the primary shoe.

To release the parking brake, pull the release lever handle located just below the lower left side of the instrument panel.

## PERIODIC SERVICE

The brake system should be checked each time the car is lubricated. When the car is raised on a lift for lubrication, brake lines, hoses, and cables should be inspected for signs of chafing, deterioration, or other damage. A careful check for leaks should be made. Repairs as necessary should be performed as outlined in this section.

If the brake pedal travels to within 2" of floor mat when brakes are applied, or if pulls, grabs, or other irregularities are noted, a need for brake service exists. Corrections should be made as outlined in this section.

The parking brake cables must be lubricated yearly or when brakes are relined.

#### *PEDAL AND STOP LIGHT SWITCH (Fig. 5-1)*

Specified pedal height for normal usage (Fig. 5-1) may be changed to accommodate special owner requirements. The pedal may be raised or lowered by moving clevis toward or away from the master cylinder. If pedal is moved it is essential to reset stop light switch. DO NOT lower pedal more than absolutely necessary as insufficient brake pedal travel may result when used at high speed with worn linings.

After changing pedal height or stop light switch, adjust stop light switch, and check pedal for freedom of movement.

*CAUTION: If stop light switch or pedal bracket prevents full return of brake pedal and master cylinder push rod, the master cylinder piston may be prevented from returning to its internal stop. This can block off the compensating port which prevents brake shoes from returning fully when the pedal is released (see Fig. 5-1). A further complication which follows a blocked compensating port is lining drag and complete brake burn-up. It is necessary that in the released position the primary cup be entirely clear of the compensating port to provide a safety factor against normal rubber swell in addition to expansion and deflection of body parts and pedal linkage.*

#### *PARKING BRAKE—ADJUST*

Automatic brake adjusters normally keep the parking brake adjusted correctly. There may be a condition where the parking brake system will require additional adjustment even though the service brakes are perfectly satisfactory.

1. Apply the parking brake slightly and check equalization by turning the rear wheels by hand.

2. If only a slight difference exists, loosen the adjusting screw of the tighter brake.

3. If equalization requires more than a few notches movement, retighten adjusting screw to point for proper adjustment of that brake and equalize rear cable by loosening the cable clamp screws at the equalizer clevis, and pulling downward on the tight side of the cable. It may be necessary to open the clamp with a screwdriver to allow the cable to equalize (Fig. 5-2).

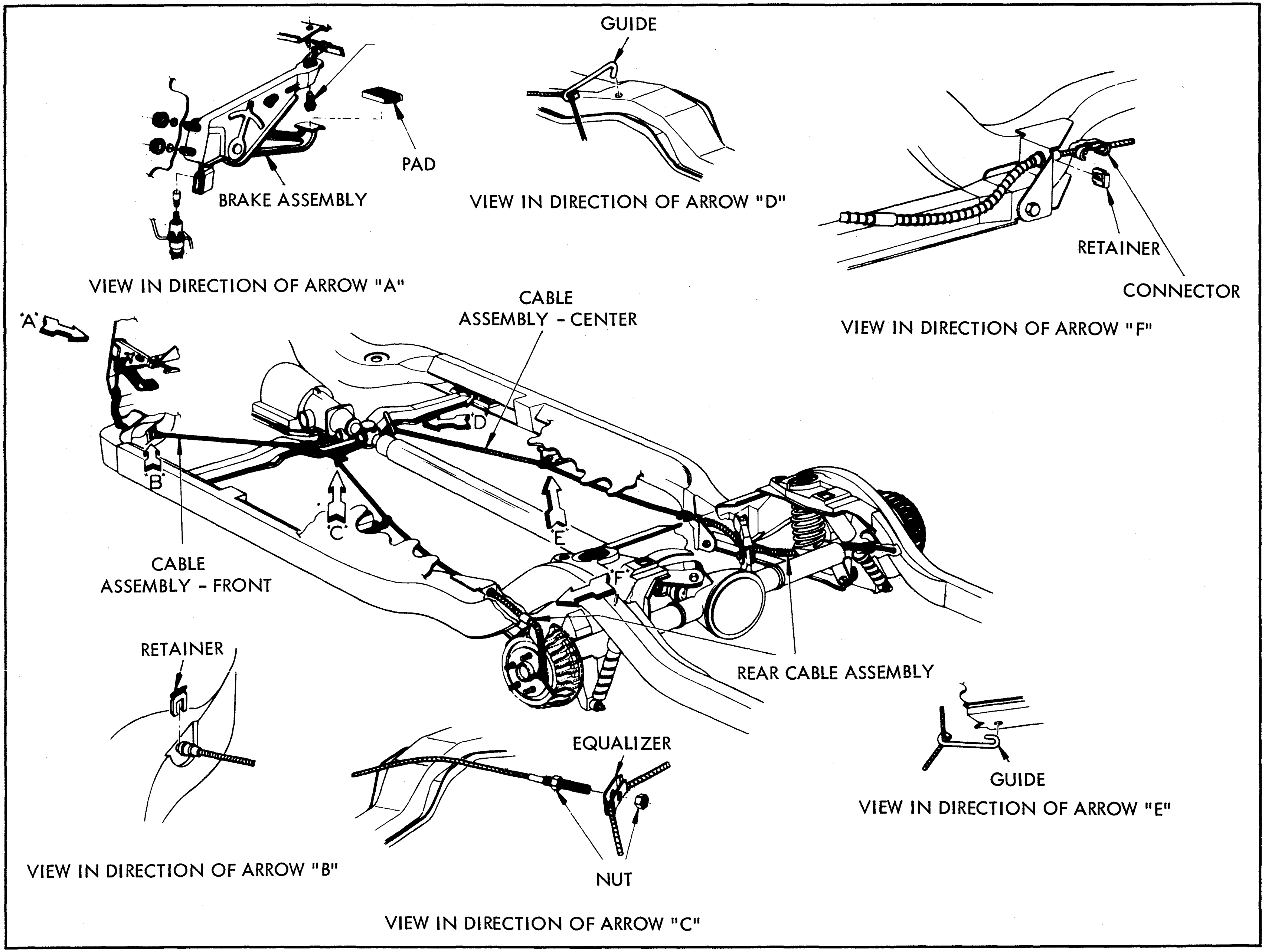



Fig. 5-2 Schematic Diagram of Parking Brake System

4. Tighten the clamp screws on the equalizer while the parking brake lever is still in the applied position. When parking brake lever is released, it should be possible to turn each wheel by hand without feeling drag when rear cable is pulled downward by the other hand, gripping cable midway between conduit and guide on frame.

*CAUTION: It is very important that parking brake cables are not adjusted too tightly to cause brake drag. With automatic brake adjusters, a tight cable causes brake drag and also positions the secondary brake shoe, hence the adjuster lever, so that it continues to adjust to compensate for wear caused by the drag. The result is a cycle of wear and adjustment that can wear out linings very rapidly.*

5. Close adjustment for tension may be secured by adjusting the clevis at the rear end of the front cable. In adjusting here, be certain to turn clevis on or off cable end and do not twist the cable (Fig. 5-2).

### BLEEDING BRAKES

Depressing the pedal with a low fluid level in master cylinder reservoir or disconnecting any part of the hydraulic system permits air to enter the system. Air may also enter the system occasionally when brake shoes are replaced. This air must be removed by bleeding.

Bleeding may either be done by operating the brake pedal using bleeder tube as outlined below, or by using pressure bleeding equipment.

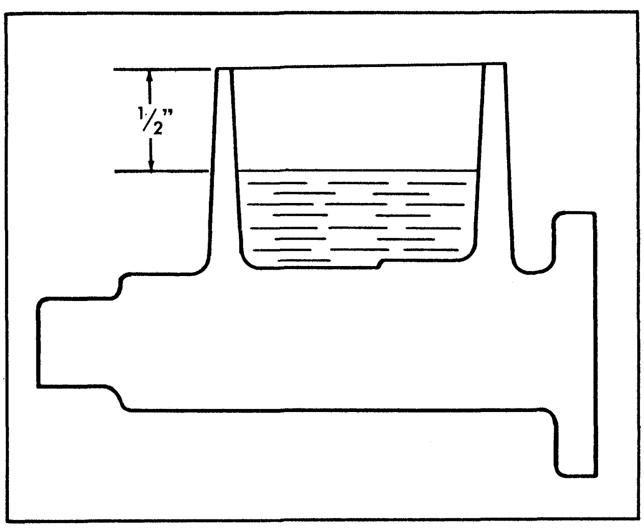



Fig. 5-3 Correct Fluid Level in Master Cylinder

When using pressure bleeding equipment follow instructions of the equipment manufacturer and always use bleeder tube attached to wheel cylinder to prevent brake fluid from running down backing plate.

When bleeding by operating pedal proceed as outlined below:

1. Fill master cylinder reservoir with recommended brake fluid.

*CAUTION: Always clean away any dirt from around master cylinder filler cap before removing cap for any reason. Never depress pedal while any brake drum is off unless bleeder valve is open.*

*Never use an inexpensive or reclaimed brake fluid as this will positively result in brake trouble. Even though reclaimed fluid may look clear, tests have shown such fluid to be corrosive. If there is doubt as to the grade of fluid in the system, flush out system and fill with recommended brake fluid complying with SAE 70R3 specifications.*

2. Starting at left front wheel, attach bleeder tube allowing tube to hang submerged in brake fluid in a clean quart jar. Unscrew bleeder valve three quarters of a turn, depress pedal a full stroke and allow it to return slowly making sure end of bleeder tube is under the surface of liquid in container. Continue operating pedal, refilling reservoir after each five strokes (unless an automatic filling device is used), until liquid containing no air bubbles emerges from bleeder tube.

3. Close bleeder valve securely and remove bleeder tube; proceed bleeding one brake at a time as described above, right front, left rear and right rear.

4. When bleeding operation is completed, refill reservoir to within 1/2" of top of master cylinder and then replace filler cap (Fig. 5-3).

## MAJOR BRAKE ADJUSTMENT

A manual brake shoe adjustment is required only when new linings are installed or whenever the length of the brake shoe adjusting screw has been changed.

Remove all four wheels then remove brake drums separately being careful to avoid damaging grease seal and blow out dust from all drums and brake assemblies.

### INSPECTION

1. Inspect drums for scoring. Road dirt frequently cuts grooves in drums which do not impair operation of brakes unless grooving is extremely severe. When drums are badly scored, inspect lining carefully for imbedded foreign material. Replace or recondition drums only when drums are badly scored.

*CAUTION: Removing material from brake drum reduces strength of drum and also the ability of drum to absorb heat, so this operation should not be done unnecessarily.*

2. Inspect front wheel bearings and oil seals and replace as necessary.

3. Note whether exterior of wheel cylinder boots is wet with brake fluid. Excessive amounts of fluid at this point indicates leakage past piston cups.

*NOTE: A slight amount of fluid is nearly always present and acts as lubricant for the piston.*

4. If an excessive amount of fluid is present, overhaul wheel cylinder.

5. Inspect hoses and hydraulic lines for wear or damage and replace as necessary.

6. Check to see that parking brake cables are not too tight as this would cause the rear brakes to drag.

7. Pull all shoe assemblies away from backing plate and apply a small amount of petroleum base lubricant to pads where brake shoes contact backing plates.

8. Remove adjusting hole covers from backing plates.

9. Reinstall brake drums and wheels.

### ADJUSTMENT

1. Using tool J-8915, expand adjusting screw to produce 14-20 lb. drag on outside of tire.

2. Insert a small rod or screwdriver through the adjusting screw slot in the backing plate and hold automatic adjuster lever away from the adjusting screw star wheel (Fig. 5-5 and 5-6).

3. Back off 30 notches.

4. After adjustment, drum rotation should be free from drag.

5. Install adjusting hole covers in backing plates.

6. Road test car to check brake operation.

### FLUSHING HYDRAULIC SYSTEM

It may sometimes become necessary to flush out the brake hydraulic system due to the presence of mineral oil, kerosene, gasoline, carbon tetrachloride,

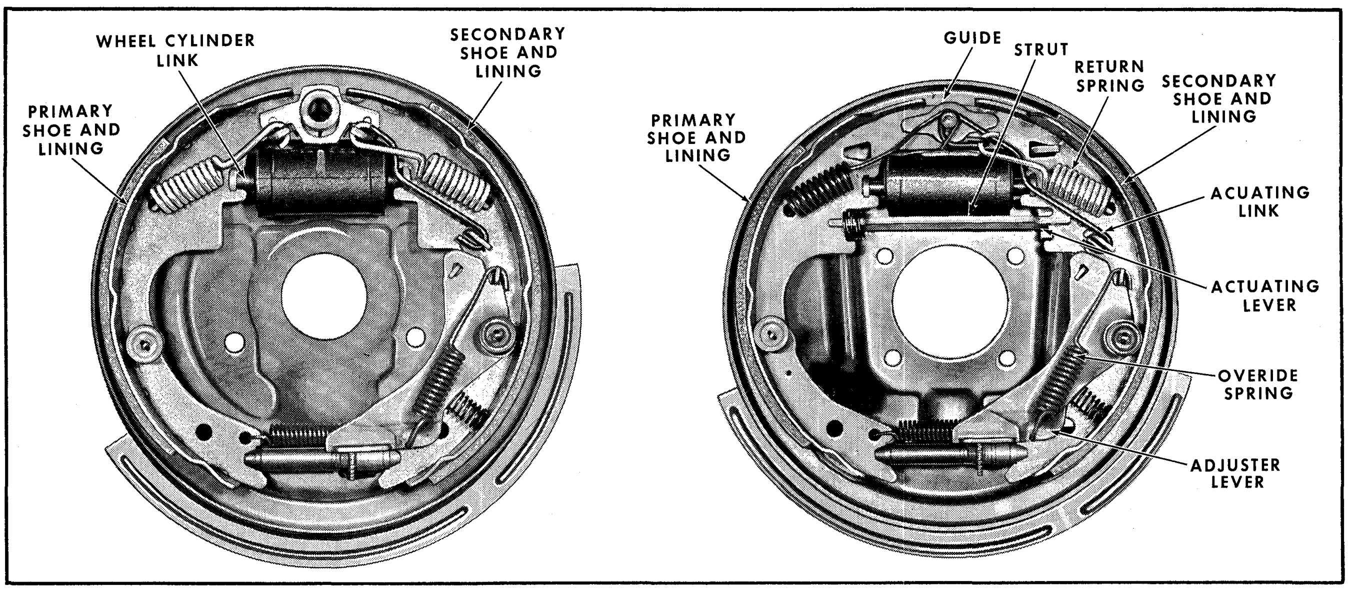



Fig. 5-4 Front and Rear Self-Adjusting Brake Assemblies

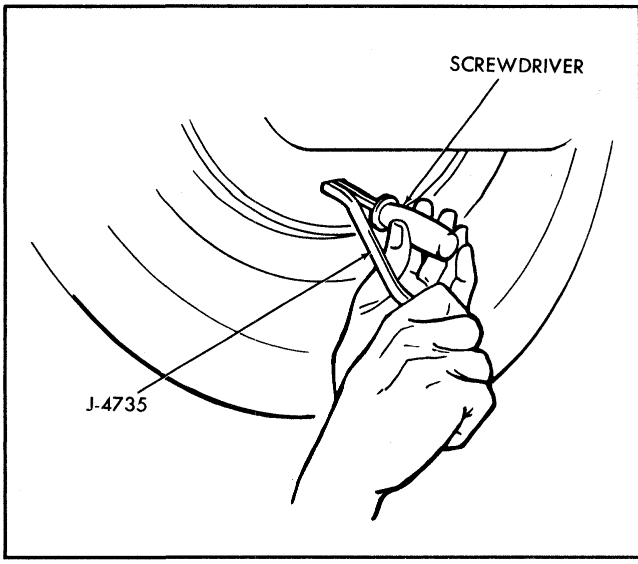



Fig. 5-5 Preparing to Back Off Adjusting Screw

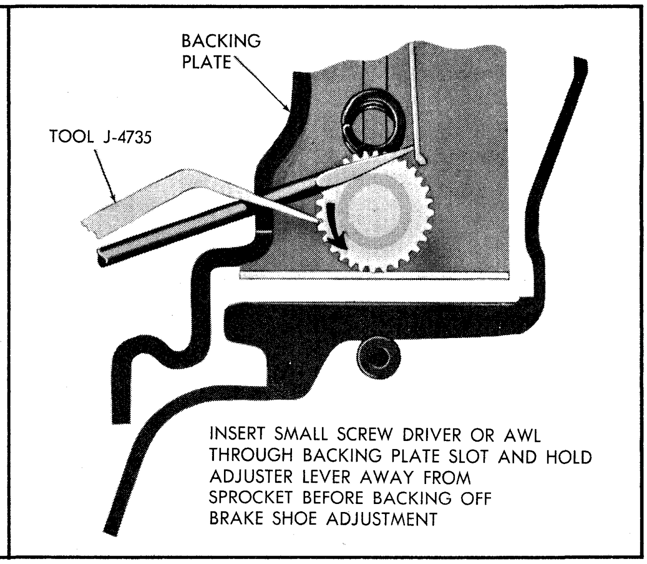



Fig. 5-6 Backing Off Adjusting Screw

etc., which will cause swelling of rubber piston cups and valves so they become inoperative.

To flush the hydraulic system, proceed as follows:

1. Attach bleeder tube and open bleeder valve at left front wheel.

2. Flush out system thoroughly with clean denatured alcohol, pumping the fluid from master cylinder reservoir and out of wheel cylinder bleeder valve.

3. Repeat steps 1 and 2 at remaining wheel cylinders. To ensure thorough flushing approximately 1/2 pint of alcohol should be bled through each wheel cylinder.

4. Replace all rubber parts in master and wheel cylinders. Thoroughly clean cylinders and pistons in alcohol before installing new parts.

5. After installing parts, fill system with recommended brake fluid and follow steps 2 through 4 under "bleeding brakes" to flush system of cleaning solution and to bleed brakes. In doing this, pump brake fluid from wheel cylinder bleeder valves until brake fluid flows from bleeder tube and then, if necessary, continue until no air bubbles emerge from bleeder tube.

### *PARKING BRAKE—LUBRICATE*

1. Thoroughly clean cable, from conduit to cable equalizer.

2. Remove retainer at forward end of conduits.

3. Unhook parking brake rear cable at connector.

4. Unhook cable from parking brake lever assembly in drum.

5. Pull the cable forward in the conduit.

6. Clean the cable, examine for broken strands, and apply light grease, chassis lubricant, or equivalent.

7. Inspect cable connections to hand brake actuating lever to be certain cable is seated in lever hook.

8. Secure rear brake cable to lever assembly.

9. Slide brake cable conduit back in position and secure at forward end with retainer.

10. Hook rear cable to connector and adjust as described under PARKING BRAKE—ADJUST.

## BRAKES—OVERHAUL (Fig. 5-7)

### *BRAKE SHOES—REMOVE*

1. Raise all four wheels off ground and disconnect parking brake equalizer.

2. Remove front wheels, front hub and drum assemblies, rear wheels and rear drums.

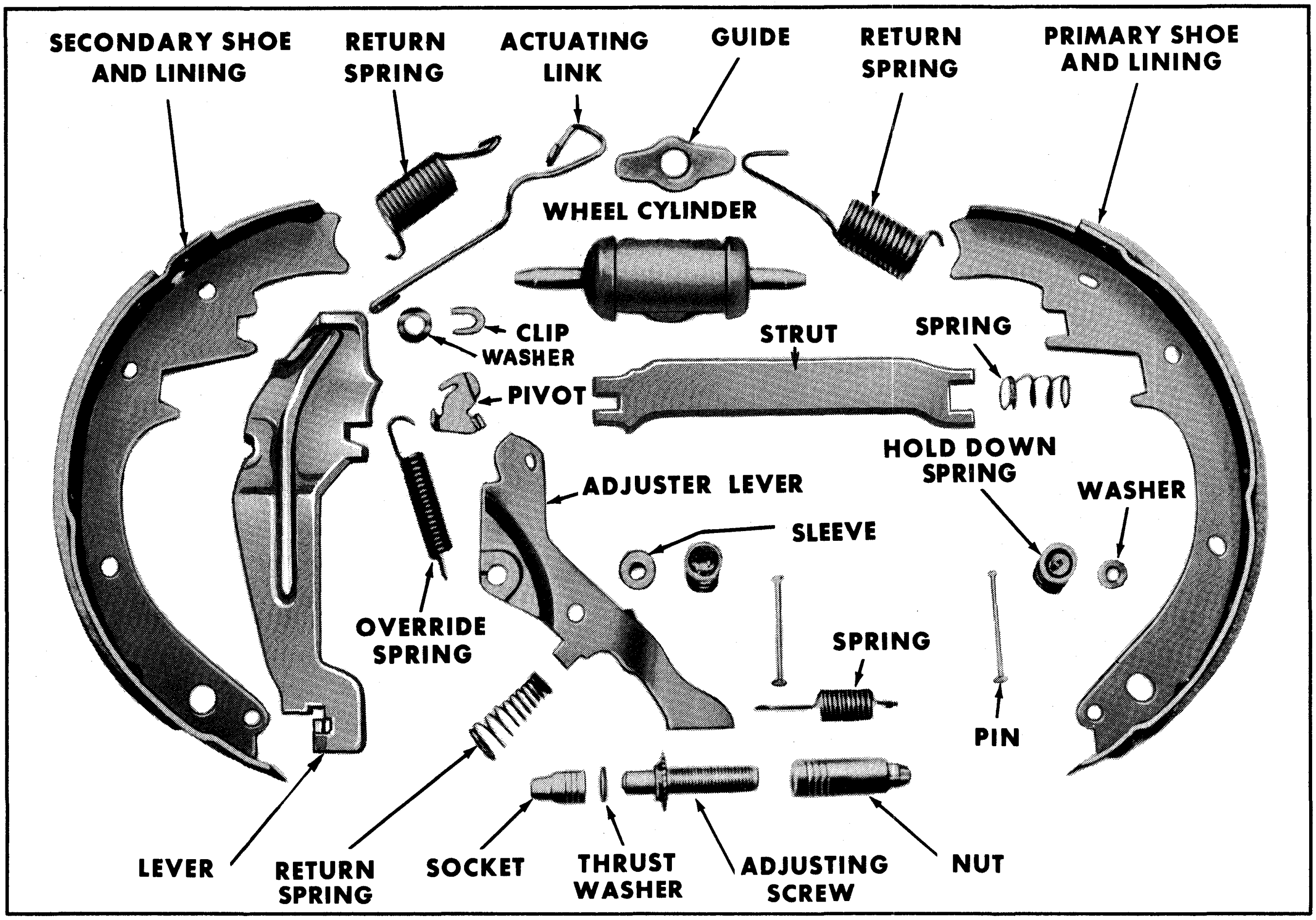



Fig. 5-7 Self-Adjusting Brake Assembly-Exploded View

*NOTE: It may be necessary to back off the brake shoe adjustment before the brake drums can be removed. To back off shoe adjustment, rotate adjusting screw upward (Fig. 5-6).*

3. Remove the primary and secondary shoe return springs.

4. Remove the actuating lever.

5. On rear brakes, spread shoes slightly and remove the parking brake lever strut and spring, then disconnect the parking brake cable from the operating lever.

6. Remove the brake shoe hold down springs, pins and washers, and the adjuster lever and return spring.

7. Spread shoes to clear wheel cylinder links, then remove the primary and secondary shoes as an assembly.

*CAUTION: Extreme care must be taken to prevent oil, grease, or brake fluid from getting on linings. Even oily finger prints on linings may affect the operation of brakes.*

8. Remove the primary to secondary shoe spring and the adjusting screw.

9. On rear brakes, remove the parking brake lever from the secondary shoe.

### BRAKE INSPECTION

1. Inspect linings for wear or cracks. Clean brake shoes, drums and backing plates, removing any foreign particles that may have become imbedded in lining surface. Examine shoes for loose rivets which must be replaced. Install new shoes or reline if linings are badly burned or worn nearly flush with rivets or if linings show evidence of oil, grease or brake fluid on the surface.

*CAUTION: In cases of severe brake usage it is possible for shoes to take the shape of worn linings permanently. Before relining a shoe, particularly if it is discolored, check for distortion by laying it against a new shoe. Discard the shoe if its radius has opened up more than the thickness of the rim metal.*

2. Inspect drums for scoring. Road dirt frequently cuts grooves in drums which do not impair operation of brakes unless grooving is extremely severe. When drums are badly scored, inspect lining carefully for imbedded foreign material. Replace or recondition drums only when severely scored.

*CAUTION: Removing material from brake drum reduces strength of drum and also the ability of drum to absorb heat, so this operation should not be done unnecessarily.*

3. Inspect front wheel bearings and oil seals and replace as necessary.

4. Note whether exterior of wheel cylinder boots is wet with brake fluid. Excessive amounts of fluid at this point indicate leakage past piston cups.

*NOTE: A slight amount of fluid is nearly always present and acts as lubricant for the piston.*

5. If an excessive amount of fluid is present, overhaul wheel cylinder.

6. Clean inner surfaces of brake backing plates and all shoe contacting points.

7. Clean exposed portions of parking brake cables.

8. Disassemble the adjusting screw assembly and inspect as follows:

a. Check thrust washer and mating surfaces for burrs or excessive wear.

b. Inspect teeth on star wheel for wear.

c. Remove all foreign material from adjusting screw and nut. Nut must rotate freely on threads.

9. Check adjuster lever to be certain it is not bent or distorted and that lock is not worn excessively.

10. Check the override pivot for wear or deformed parts.

11. Check brake drum for build-up of rust and dirt at outer circumference. Remove build-up.

12. Inspect hoses and hydraulic lines for wear or damage and replace as necessary.

13. Check to make sure all bolts and nuts securing backing plate to suspension are tightened to 80-110 lb. ft. torque at upper plate to knuckle bolt, 45-65 lb. ft. torque at lower bolt and 30-45 lb. ft. torque on all rear plate to axle flange bolts.

### BRAKE SHOES—INSTALL

1. Lubricate the adjusting screw threads, thrust washer mating surfaces, backing plate ledges and all other contacting surfaces with a small amount of brake lubricant or wheel bearing lubricant. Do not lubricate teeth of star wheel of adjusting screw.

2. Pull parking brake rear cable forward and rearward through conduit and examine for broken strands. Lubricate freely with light grease or chassis lubricant and return cable to normal position. Remove any excess lubricant.

3. On rear brake assemblies, install the parking brake lever to the secondary shoe.

4. Assemble the adjusting screw.

5. Attach the primary to secondary shoe spring to the shoes, and install the adjusting screw. The primary to secondary shoe spring must not contact the adjusting screw star wheel.

*NOTE: The right front and right rear adjusting screws have left hand threads and can be identified by 4 grooves. All adjusting screws must be installed with the star wheel end of the screw toward the rear of the car.*

6. Position shoe assembly on the backing plate. Be sure wheel cylinder links are properly positioned in the shoe notches.

*NOTE: When replacing shoes, always be certain to assemble secondary shoes to the rear and primary shoes to the front. Note that linings of primary shoes are lighter in color than secondary linings.*

7. On rear brakes, connect parking brake lever to secondary shoe and install strut and spring between lever and primary shoe.

8. Position the upper end of actuating link on the brake shoe guide.

9. Engage the actuating lever with the override pivot then position the adjuster lever and return spring on the secondary shoe. Fasten with hold down spring assembly.

*NOTE: The front brake hold down spring retaining pins are identified with the numeral 1 stamped on the outer face. The rear brake retaining pins being identified with the numeral 8 stamped on the outer face.*

10. Install the remaining hold down springs.

11. On rear brakes, install the parking brake cable on the parking brake lever.

12. Install the primary and secondary brake shoe return springs.

*NOTE: New brake shoe return springs should be installed if old springs have been overheated or strength is doubtful. Overheated springs may be indicated by ends of coils opened up or failure of shoes to return to anchor pin.*

13. Sand linings lightly to remove any trace of dirt.

14. When new shoes or linings have been installed, shorten adjusting screw until drum will slide freely over shoes and check to see that adjusting actuator lever can turn adjusting screw star wheel with minimum effort.

15. Install drums, observing instructions for front wheel bearing adjustment.

16. Adjust brake shoes as described in this section under MAJOR BRAKE ADJUSTMENT.

17. If wheel cylinder has been replaced or repaired or hydraulic line has been replaced, bleed brakes as described in this section on BLEEDING BRAKES.

18. Install wheels.

19. Adjust parking brake as outlined under PARKING BRAKE—ADJUST.

20. Check fluid level in master cylinder. Fluid level should be 1/2" below the reservoir opening.

21. Check brake pedal travel to be sure it is within specifications, then road test car for proper operation of the brake system.

*CAUTION: New linings must be protected from severe usage for several hundred miles. Stops from high speeds or repeated stops from low speed may permanently injure new linings. This information should be conveyed to owner.*

### WHEEL CYLINDER—REMOVE AND REPLACE

REMOVE

1. Raise wheels of vehicle and remove wheel then drum.

2. Disconnect hose from wheel cylinder.

3. Remove brake shoes to protect them from dripping fluid.

4. Remove screws and lockwashers which hold cylinder to backing plate and remove wheel cylinder.

DISASSEMBLE (Fig. 5-8)

1. Remove wheel cylinder connecting link.

2. Remove rubber boots.

3. Remove pistons, rubber cups, and spring.

*CAUTION: Before cleaning parts, clean hands. Do not wash hands in gasoline or fuel oil before cleaning parts, use soap and water.*

4. Wash all parts in clean alcohol and lay on a clean surface (such as a clean piece of paper).

5. Protect parts from dirt until reassembly.

INSPECT

1. Inspect piston rubber cups for softening, distortion, or swelling. This condition indicates oil, gasoline, carbon tetrachloride, etc., in hydraulic system which would require flushing of system, and replacing of rubber parts in wheel cylinders as well as in master cylinder.

2. See that rubber cups are flared so they will have tension against the cylinder bore. Loss of flare may be caused by overheating.

3. Examine spring, cylinder bore, and pistons for signs of scoring, rust, pitting or etching. Any of these require replacement of wheel cylinder.

*NOTE: A new brake cylinder has a "bearingized" surface. This is accomplished by diamond boring the cylinder then rolling it under heavy pressure to obtain a highly polished hard surface. Honing this surface destroys the "skin" and leaves a softer and rougher surface which will cause more rapid piston wear than the "bearingized" surface. Honing also enlarges the bore and oversize pistons are not available.*

ASSEMBLE

1. Apply clean brake fluid to cylinder bore, pistons, and rubber cups before assembly.

2. Place a boot in one end of cylinder.

3. Place a piston in cylinder so that flat side will be toward center of completed assembly.

4. Insert a rubber cup with flat side against piston.

5. Insert spring and expander assembly.

6. Insert a rubber cup with flat side toward opening.

7. Install piston with flat side against cup.

8. Place rubber boot in end of cylinder.

REPLACE

1. Install wheel cylinder on backing plate with screws and lockwashers. Tighten to 60-90 pound inches of torque.

2. Replace wheel cylinder connecting links.

3. Install brake shoes.

4. Connect hose or pipe to wheel cylinder (use new gasket with hose).

5. Install brake drums and adjust wheel bearings, if front drum was removed.

6. Bleed all brake lines as described under BLEEDING BRAKES in this section.

7. Adjust and test brakes as previously described in this section.

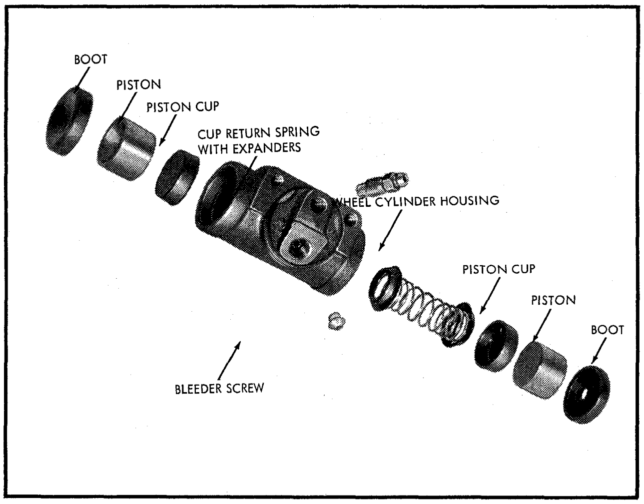



Fig. 5-8 Wheel Cylinder-Exploded View

## MASTER CYLINDER—REMOVE AND REPLACE

REMOVE

1. Disconnect brake pedal return spring.

2. Remove retainer and clevis pin from clevis.

3. Remove hydraulic brake line from end of master cylinder. Cover line and plug cylinder to exclude dust, dirt, etc.

4. Remove two nuts and lockwashers, holding master cylinder to dash.

5. Remove master cylinder from automobile.

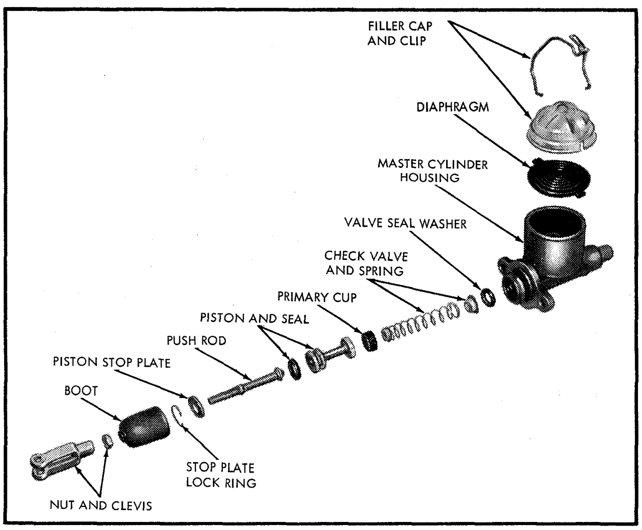



Fig. 5-9 Master Cylinder-Exploded View

DISASSEMBLE (Fig. 5-9)

1. Remove reservoir cover and diaphragm from top of master cylinder and dump fluid.

2. Clamp cylinder in vise.

3. Remove clevis and lock nut from push rod.

4. Remove boot from master cylinder.

5. Carefully remove push rod stop plate lock ring from end of cylinder.

*NOTE: Ring is under high tension, use eye protection.*

*CAUTION: When lock ring is removed piston spring will force piston and stop plate out of cylinder with 10-15 lbs. of force.*

6. Remove piston, piston cups, piston spring, and check valve assembly from cylinder.

*CAUTION: Before cleaning parts, clean hands. Do not wash hands in gasoline or fuel oil before cleaning parts, use soap and water.*

7. Wash all parts in clean alcohol and lay on a clean surface (such as a sheet of clean paper).

8. Protect parts from dirt until reassembly.

INSPECT

1. Inspect piston rubber cups and check valve for softening, distortion or swelling. This indicates oil, gasoline, carbon tetrachloride, etc. in hydraulic system which would require flushing of entire system and replacing of rubber parts in wheel cylinders as well as in master cylinder.

2. Inspect master cylinder bore for signs of scoring, rust, pitting, or etching. Any of these will require replacement of master cylinder. Presence of pitting, rust, or deep etching in master cylinder calls for replacement and careful inspection for similar condition in all wheel cylinders.

*CAUTION: A new brake cylinder has a "bearingized" surface. This is accomplished by diamond boring the cylinder then rolling it under heavy pressure to obtain a hard surface. Honing this surface destroys the "skin" and leaves a softer and rougher surface which will cause more rapid piston and cup wear than the "bearingized" surface. Honing also enlarges the bore and oversize pistons are not available.*

ASSEMBLE

1. Install washer, check valve and spring in cylinder..

2. Coat primary cup with clean brake fluid and install in cylinder with flat side toward rear; make certain cup seats over end of spring.

3. Coat secondary cup with clean brake fluid and install on piston, with sharp edges of lip pointing toward perforated end of piston.

4. Install secondary cup and piston in cylinder so that flat end of piston is toward front of cylinder.

5. Install push rod and stop plate in cylinder. (A trace of silicone grease on ball end of push rod will help keep it quiet in service.)

6. Install push rod stop plate lock ring in cylinder.

*CAUTION: Use eye protection.*

*NOTE: Inspect piston stop washer in end of master cylinder to see that it is held firmly in place by lock ring bottoming fully in groove seat in master cylinder.*

7. Place rubber boot on end of cylinder.

8. Install lock nut and clevis on push rod.

9. Fill reservoir.

10. Install reservoir cover and diaphragm.

REPLACE

1. Install master cylinder on dash and secure with two nuts and lockwashers. Tighten to 15-25 lb. ft. torque.

2. Connect master cylinder push rod and clevis to brake pedal with clevis pin and secure with retainer.

3. Connect brake pedal return spring.

4. Check and adjust pedal height and stop light switch.

5. Connect hydraulic line to master cylinder.

6. Check level after working pedal several times. Fill master cylinder with recommended fluid to within 1/2" of top of cylinder and replace filler cap (Fig. 5-10).

7. Brake system may be bled as described in this section on BLEEDING BRAKES if necessary.

8. Adjust and test brakes as outlined previously in this section.

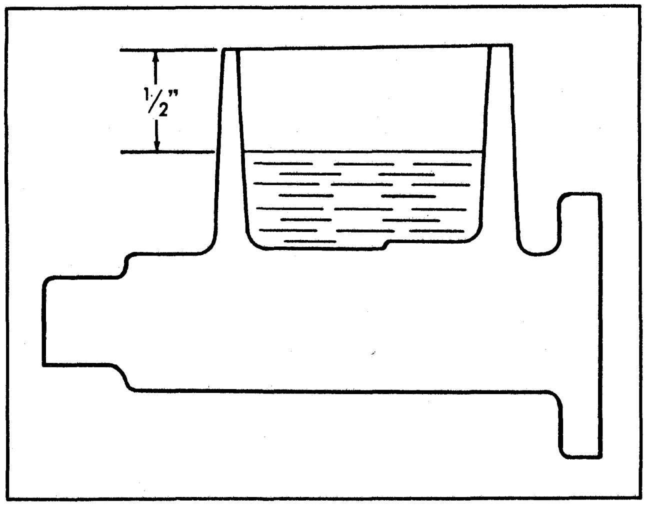



Fig. 5-10 Correct Fluid Level in Master Cylinder

## TROUBLE DIAGNOSIS AND TESTING

### *TESTING FOR LEAK IN HYDRAULIC SYSTEM*

*NOTE: If there is any evidence of air in system, brakes must be bled before making this test.*

1. Apply brakes manually, holding as steady a force as possible.

2. If pedal sinks slowly toward floor, a leak is indicated. Check for location of the leak by examining all lines, connections, wheel cylinders and inside of master cylinder boot. If external leak is not found, remove master cylinder, disassemble and inspect parts. Leak will usually be past primary piston cup due to defective cup or cylinder bore.

*NOTE: If leak at wheel cylinder has allowed fluid to reach linings, they must be replaced.*

The following is a list of common troubles occurring in the brake system with possible causes and remedies:

### *PEDAL GOES TO TOE BOARD*

| CAUSE | REMEDY |
|---|---|
| Automatic adjusters not working. | Inspect for inoperative condition and correct as necessary. |
| Normal wear of lining. | Readjust or replace lining. |
| Low fluid level in master cylinder reservoir. | Low fluid level in reservoir will permit air to be pumped into hydraulic lines. This necessitates refilling reservoir and bleeding lines. Find cause of low fluid and correct. |
| External leak in hydraulic system, or leak past master cylinder primary piston cup. | Check for leak in system as outlined above. |
| Air trapped in hydraulic system. | Air trapped in hydraulic system gives pedal a spongy feeling when depressed. Bleed brakes. |

### *ALL BRAKES DRAG AFTER BRAKE ADJUSTMENT IS CHECKED AND FOUND TO BE CORRECT, OR PEDAL BUILDS UP WITH USE*

| CAUSE | REMEDY |
| --- | --- |
| Mineral oil, etc., in system. | The presence in the hydraulic system of any mineral oil, kerosene, gasoline, shock absorber or transmission fluid or carbon tetrachloride will cause swelling of rubber piston cups and valves, so they become inoperative. This is first noticed in the master cylinder. Brakes will not release freely if master cylinder primary piston cup has swollen sufficiently to obstruct the compensating port. Flush system thoroughly with a good grade of clean denatured alcohol and replace all internal rubber parts in brake system. |
| Pedal does not return freely or push rod is adjusted too long. | Lubricate pedal linkage and make certain no bind exists. Also, see that pedal return spring has not lost its tension and promptly returns pedal. Check that stop light switch is not defective, incorrectly adjusted or that switch plunger is not binding. |
| Compensating port of master cylinder closed. | The compensating port in master cylinder must be completely clear when pedal is in released position.<br>1. Check that pedal returns freely.<br>2. Check that push rod is not adjusted too long.<br>3. Check that compensating port is not plugged by dirt. To check compensator port, remove master cylinder reservoir cover and watch the fluid in the cylinder as the brake pedal is moved. A "geyser" should be seen as the pedal is first depressed. If no geyser is seen, the compensating port is blocked.<br>4. Inspect master cylinder piston cup and if found to be swollen or elongated, flush system and replace damaged parts. |

### *ONE WHEEL DRAGS*

| CAUSE | REMEDY |
| --- | --- |
| Improperly adjusted parking brake cables (rear wheels only) or stuck cable. | Adjust parking brake cables and lubricate. |
| Weak or broken brake shoe return springs. | Replace defective brake shoe springs and lubricate brake shoe pads and shoe contact at anchor pin with grease. |

| | |
|---|---|
| Brake shoe or drum clearance too small. | Readjust brakes to obtain complete freedom from drag. |
| Loose or incorrect front wheel bearings. | Adjust front wheel bearings or replace as described in section 3. |
| Wheel cylinder piston cups swollen or distorted or piston stuck. | Replace defective or damaged parts. Look for evidence of dirt in hydraulic system which could cause damage to the cylinders or cups. See first item under ALL BRAKES DRAG . . . |
| Obstruction in line. | Obstruction in line may be caused by foreign material in line or flattened or kinked tube. If dirt is found in line, remove obstruction and flush hydraulic system with fresh brake fluid. If tube is flattened or kinked, replace damaged parts. |
| Support assembly shoe pads grooved. | Grind or file pads on backing plate smooth and lubricate. |
| Incorrect brake shoe radius. | Replace defective brake shoe. |

### *BRAKES DO NOT AUTOMATICALLY ADJUST*

| CAUSE | REMEDY |
|---|---|
| Worn, bent or distorted adjuster lever. | Replace adjuster lever. |
| Improper secondary lining to drum clearance. | Adjust clearance. |
| Brake linings excessively worn. | Install new linings. |

### *CAR PULLS TO ONE SIDE*

| CAUSE | REMEDY |
|---|---|
| Grease or fluid on lining. | Replace with new linings. Linings with even a slight trace of grease or fluid will cause trouble, and can seldom be salvaged by cleaning. Correct cause of grease or fluid reaching linings. |
| Loose wheel bearings. | Adjust wheel bearings. |
| Loose backing plate at rear axle or front axle. | Tighten backing plate. |
| Linings not to specifications, or primary and seconday shoes reversed. New and used linings mixed on one end of car. | Various kinds of linings have different friction effect on the drums and on each other. Each wheel must have similar linings. The primary and secondary linings must not be interchanged. Use only factory specified linings. |

| | |
|---|---|
| Tires not properly inflated or unequal wear of tread. | Inflate tires to specified pressures. Rearrange tires so that a pair with tread surfaces of similar wear will be installed on front wheels. |
| Linings charred or drums scored. | Sand surfaces of linings and drums. Remove particles of metal that have become embedded in surfaces of linings. See COMPLETE BRAKE RECONDITIONING, regarding road dirt grooving brake drums. Seriously charred linings should be replaced. |
| Wheel cylinder link off shoe. | Check boot for holes. Check for burrs on wheel cylinder piston. |
| Water, mud, etc., in brakes. | Remove any foreign material from all brake parts and the inside of drums. Lubricate shoe pads and rear brake cable with grease. Examine support assembly for damage. |
| Weak chassis springs, loose steering gear, etc. | Replace springs, adjust steering gear, etc. |
| Incorrect geometry setting of suspension. | Adjust geometry so that car does not have a tendency to "lead" when driven on a level road. |

### *SPONGY PEDAL*

| CAUSE | REMEDY |
|---|---|
| Air trapped in hydraulic system. | Remove air by bleeding (if bleeding is not effective check for closed compensating port). |
| Brake adjustment not correct. | Adjust brakes. |
| Bent shoes. | Replace. |
| Compensating port closed. | See ALL BRAKES DRAG. |

### *EXCESSIVE PEDAL PRESSURE REQUIRED TO STOP CAR*

| CAUSE | REMEDY |
|---|---|
| Brake adjustment not correct. | Adjust brakes. |
| Improper lining. | Install factory specified lining. |
| Grease or fluid soaked linings. | Correct cause and replace linings. See BRAKE CAUTIONS. |
| Rusted wheel cylinder. | Replace necessary parts. |
| Wheel cylinder link incorrectly aligned. | Check wheel cylinder piston and boot for damage. Install link. |

| | |
|---|---|
| Compensating port not cleared. | Check pedal linkage, stop light switch adjustment, etc. See also "Compensating Port" under "All Brakes Drag . . .". |

***LIGHT PEDAL PRESSURE—BRAKES TOO SEVERE***

| CAUSE | REMEDY |
|---|---|
| Brake adjustment not correct. | Adjust brakes. |
| Loose support assembly on rear axle or front spindle. | Adjust front wheel bearings and tighten front backing plates. Tighten rear backing plates. Adjust brakes. |
| Small amount of grease or fluid on linings. | Correct cause and replace linings. |
| Charred linings or scored drums. | Sand surfaces of linings and drums. Clean loose dust from brakes and drums. In severe cases replace shoes. Caution owner regarding abuse of brakes. |
| | Remove all particles of metal that have become embedded in surfaces of linings. Slightly scored drums do not require replacing or turning. |
| Improper linings. | Install factory specified linings. |

***BRAKE NOISES***

| NOISE | CAUSE | REMEDY |
|---|---|---|
| 1. *Squeak in brake with car stationary (sometimes mistaken for pedal squeak). | Shoe pads on backing plates dry and rusty. | Pry shoes out with screwdriver—apply grease sparingly to shoe pads with feeler stock. |
| 2. *Creak when brakes are applied at low car speed. | Anchor pins dry. | Lubricate where shoes bear. |
| 3. *Snaps in brakes as pedal is applied, car stationary. | Hold down nail heads dry. | Lubricate. |
| 4. Pedal squeak. | Return spring or stop light switch rubbing pedal. | Lubricate. |
| 5. Crunch or groan, holding car on hill. | Brake dust and possibly linings which have been overheated. | Sand linings and remove dust from brakes. |
| 6. High pitch squeak while brakes operate. | A. New linings not yet fully burnished. | Let run or sand off high spots of linings. |
| | B. Persistent squeak—no apparent cause. | Sand linings for temporary cure of mild cases. |

| NOISE | CAUSE | REMEDY |
|---|---|---|
| | C. Bonded linings. | Install factory specified shoes. |
| 7. Low pitch squeal at end of high rate stop. | A. New linings not fully burnished. | Check adjustment. Sand lining high spots. |
| | B. Incorrect adjustment. | Adjust. |
| | C. Bent backing plate (top of shoe webs should be in line with each other looking down on them. Check after pushing shoes toward backing plate at top). | Straighten or replace. |
| 8. Clicks during high rate stops, usually once per wheel revolution in one wheel only. | Threaded drum. | Disappears with usage as drum surface is conditioned by lining wear. |
| 9. Chatter at high speed. | Drum out of round with 2 or more distinct high spots in circumference. | Sometimes corrects with usage. Turn drum. |
| 10. Pedal throb at light applications at low speed. | Drum out of round simply off center. | Turn drum. |
| 11. "Rough feel" during high rate stops from moderate speed. | Tool chatter. Look for faint light and darker stripes running across the braking surface. | Usually corrects with usage. |
| 12. *Click, first application after reversing. | Shoes holding out from anchor pins. | File shoe pads on backing plates; lubricate. |
| | Incorrect parking brake adjustment. | Check parking brake adjustment. |

*Although adjusting brakes temporarily changes these noises, lubrication will remedy.

## BRAKE CAUTIONS

1. Do not use a substitute for recommended brake fluid (see below) or reclaimed brake fluid.

2. Do not allow grease, paint, oil or brake fluid to come in contact with brake lining.

3. Do not handle brake shoes or drums with greasy hands.

4. Do not clean rubber parts or inside of cylinders with anything but clean alcohol, or clean brake fluid.

5. Do not use any linings other than those specified by the factory.

6. Do not allow master cylinder reservoir to become less than half full of brake fluid.

7. Under no circumstances should brakes be severely used after new shoes are installed. They should be given moderate use for several hundred miles until linings become well burnished. Repeated severe applications will cause erratic brake action and may permanently injure brake linings. Under no circumstances should severe testing be done that will burn the linings.

8. When linings of one brake require replacement, the linings should also be replaced on the other brake at the same end of the car (except on very low mileage new cars on which the brakes have not been abused).

## SPECIFICATIONS

### NEW DRUMS

Inside diameter—Front and Rear . . . . . 9-1/2"

Out of Round including taper for full width (max.)
—Front . . . . . . . . . . . . . . . . . . .005"
—Rear . . . . . . . . . . . . . . . . . . .006"

Indicator reading shall not vary more than .0005" per inch of circumference.

### FLUID

Fluid that complies with heavy duty standards of S.A.E. 70R3 Specifications.

### LINING

Width—Front . . . . . . . . . . . . . . . . 2-1/2"
—Rear . . . . . . . . . . . . . . . . . 2"
Thickness (Front and Rear)—Primary . . . 0.196"
—Secondary . . 0.265"

### MASTER CYLINDER BORE

. . . . . . . . . . . . . . . . . . . . . . . . . 1"

### PEDAL HEIGHT

Underside of Pedal Pad
to Floor Mat . . . . . . . . . . . 5-3/4" ± 1/8"

### WHEEL CYLINDER BORE

—Front . . . . . . . . . . . . . . . . . . . 1-1/8"
—Rear . . . . . . . . . . . . . . . . . . . 1-5/16"

## TORQUE SPECIFICATIONS

| | LB. FT. |
|---|---|
| Front brake assembly to steering knuckle—lower Bolt and Nut | 45-65 |
| Front brake assembly to steering knuckle—upper Bolt (Bolt Lubricated) | 80-110 |
| Rear brake assembly to axle housing Bolt and Nut | 30-45 |
| Brake master cylinder assembly to dash Nut | 15-25 |
| Wheel cylinder to backing plate Screw | 5-7 |
| Wheel brake cylinder bleeder Screw | 5-10 |
| Parking brake lever assembly to dash Nut | 10-18 |
| Parking brake front cable to equalizer Nut | 5-10 |

## SPECIAL TOOLS

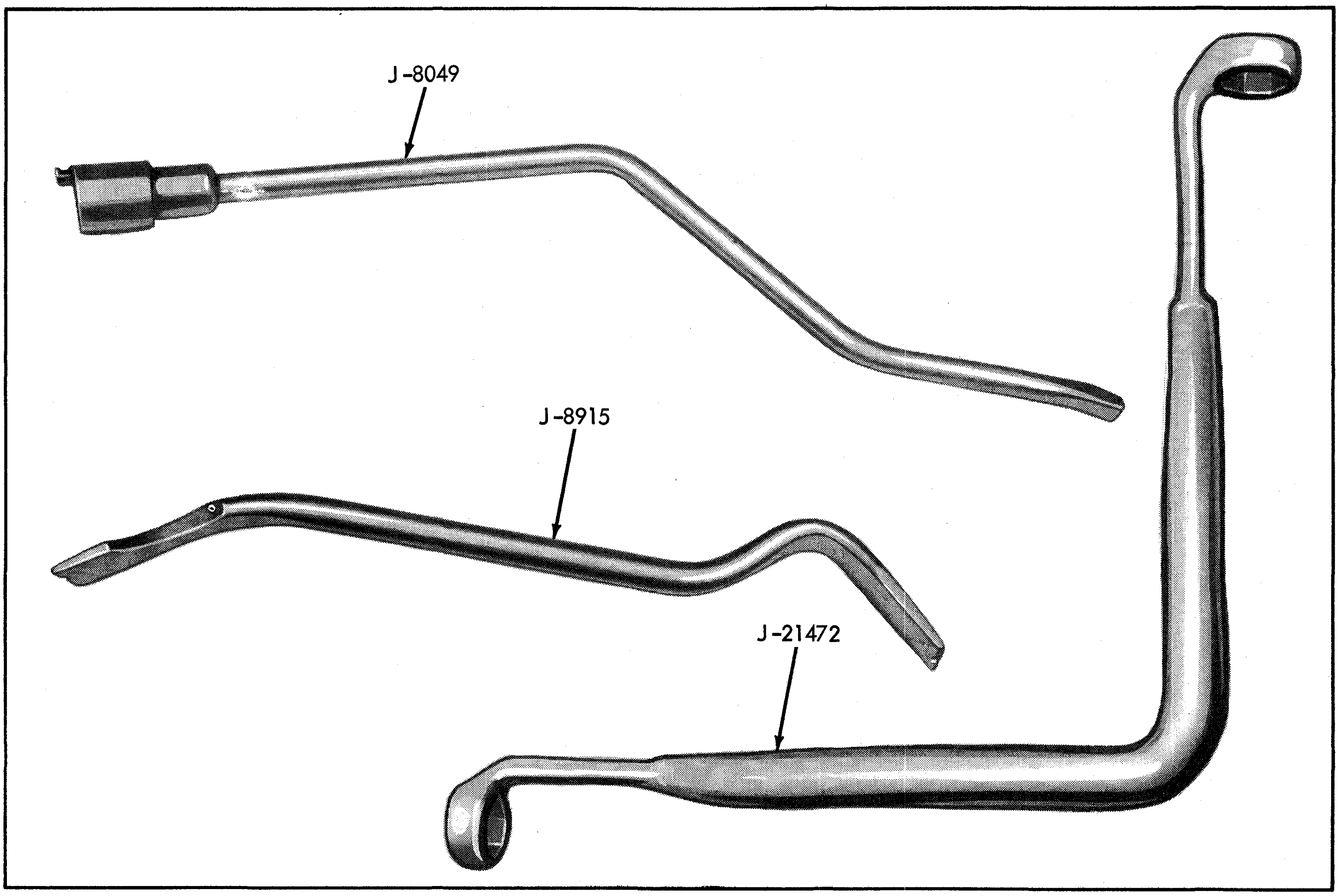



Fig. 5-11 Tempest Brake Tools

# DELCO-MORAINE POWER BRAKE

## CONTENTS OF THIS SECTION



## GENERAL DESCRIPTION

The Delco Moraine Power Brake Unit is a combined vacuum and hydraulic unit which utilizes engine intake-manifold vacuum and atmospheric pressure to provide power-assisted application of vehicle brakes. The Unit takes the place of a conventional brake system's master cylinder. From the master cylinder connection outward to the wheel units, there is no other change in the brake system. In addition to the master cylinder connections, the Unit requires a vacuum connection to the engine intake-manifold (througn a vacuum check valve) and a mechanical connection to the brake pedal. The Unit is self-contained with no external rods or levers exposed to dirt or moisture.

The Power Brake Unit provides lighter pedal pressures. These lighter pedal pressures are obtained with reduced pedal travel, making it possible to bring the brake pedal down to the approximate height of the accelerator pedal when at closed throttle position. Thus, the driver, after closing the throttle, can shift his toe from one pedal to the other without lifting his heel from the floor.

The vacuum check valve permits several applications of the Power Brake Unit with vacuum assist after the engine has stopped or because of any other loss of vacuum. After the vacuum stored in the Unit has been lost, or in case of vacuum failure at the Unit or its vacuum connections, the brakes can be applied in the conventional manner. Since the vacuum assist is not available, the pedal pressure will be higher.

### DESIGN

The Unit is composed of two main sections: the vacuum power cylinder, and the hydraulic master cylinder.

The vacuum power cylinder contains the power piston assembly which houses the control valve and reaction mechanism, and power piston return spring. The control valve is composed of the air valve and floating control valve assembly. The control valve is operated by a push rod that projects through the end of the power cylinder housing. An air filter element is assembled around the push rod and fills the cavity inside the hub of the power piston. A rubber boot protects the air filter. The reaction mechanism consists of a hydraulic piston reaction plate and a series of levers. A vacuum check valve assembly is mounted in the front housing assembly for connection to the vacuum source.

A fluid reservoir is integrally cast with the master cylinder and supplies fluid to the space between the primary and secondary seals through a hole in the casting.

Connection is made to the wheel cylinder through the hydraulic outlet and a conventional check valve.

## PRINCIPLES OF OPERATION

### *RELEASED POSITION (Fig. 5A-1)*

A line from the engine intake-manifold is connected to the vacuum check valve in the front housing of the power brake. The check valve is to prevent loss of vacuum when manifold vacuum falls below that in the power brake system.

In the released position the air valve is seated on the floating control valve. Air under atmospheric pressure, which enters through the filter element in the tube extension of the power piston, is shut off at the floating control valve. The vacuum, which is present at all times in the space to the left of the power piston, is free to evacuate any existing air on the right side of the power piston. This air is drawn over the floating control valve seat and through two small passages in the power piston then into the space at the left of the power piston. It is then drawn through the check valve to the vacuum source.

In this position there is vacuum on both sides of the power piston, which is held against the rear housing by the piston return spring. At rest, the hydraulic reaction plate and the reaction levers are held back against the reaction retainer by the air valve spring. The air valve return spring holds the air valve back so its retaining ring rests against the power piston.

The floating control valve assembly is held against the air valve seat by the control valve spring.

In this position, the by-pass hole in the hydraulic master cylinder is open to the reservoir and fluid can flow freely in either direction between the hydraulic cylinder and the fluid reservoir.

A residual pressure is maintained in the brake lines by the hydraulic check valve and its spring in the master cylinder.

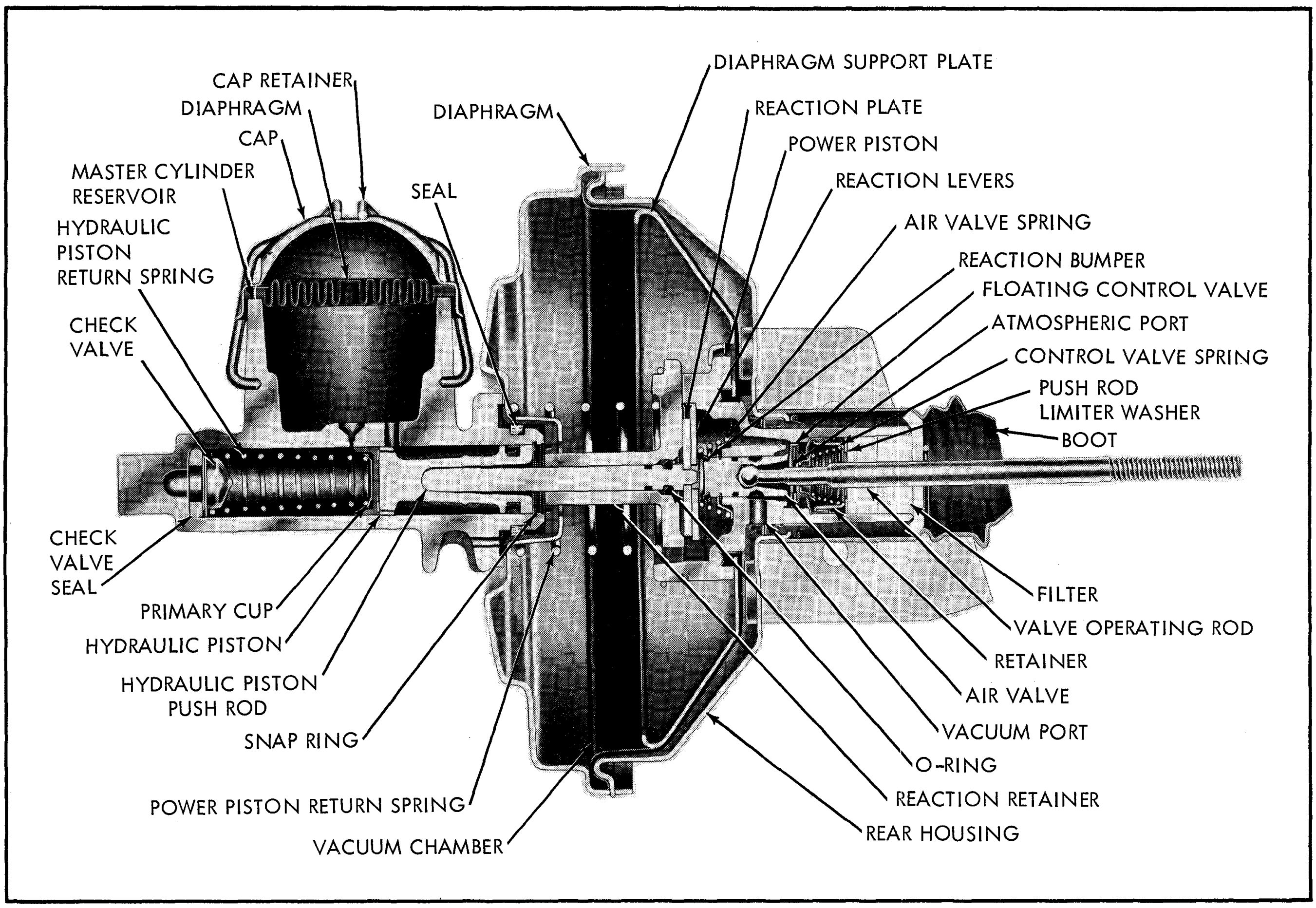



Fig. 5A-1 Released Position

### *APPLYING POSITION (Fig. 5A-2)*

As the pedal is depressed, the push rod carries the air valve away from the floating control valve. The floating control valve will follow until it is in contact with the raised seat in the power piston. When this occurs, the vacuum is shut off to the right hand side of the power piston, and air under atmospheric pressure rushes through the air filter and travels past the seat of the air valve and through two passageways into the housing on the right of the power piston.

Since there is still vacuum on the left side of the power piston, the force of the air at atmospheric pressure on the right of the piston will force the power piston to travel to the left.

As the power piston travels to the left, the piston rod carries the master cylinder piston into the bore of the master cylinder. As the master cylinder piston primary cup passes the by-pass hole, hydraulic pressure starts to build up in the hydraulic system. As the pressure builds up on the end of master cylinder piston, the hydraulic reaction plate is moved off its seat on the reaction retainer and presses against the reaction levers.

The levers, in turn, swing about their pivots and bear against the end of the air valve-push rod assembly.

In this manner, approximately 30% of the load on the piston is transferred back through the reaction system to the brake pedal. This gives the operator a feel which is proportional to the degree of brake application.

### *HOLDING POSITION (Fig. 5A-3)*

When the desired pedal pressure is reached, the power piston moves to the left until the floating control valve, which is still seated on the power piston, again seats on the air valve. The power brake will now remain stationary, until either pressure is applied or released at the brake pedal.

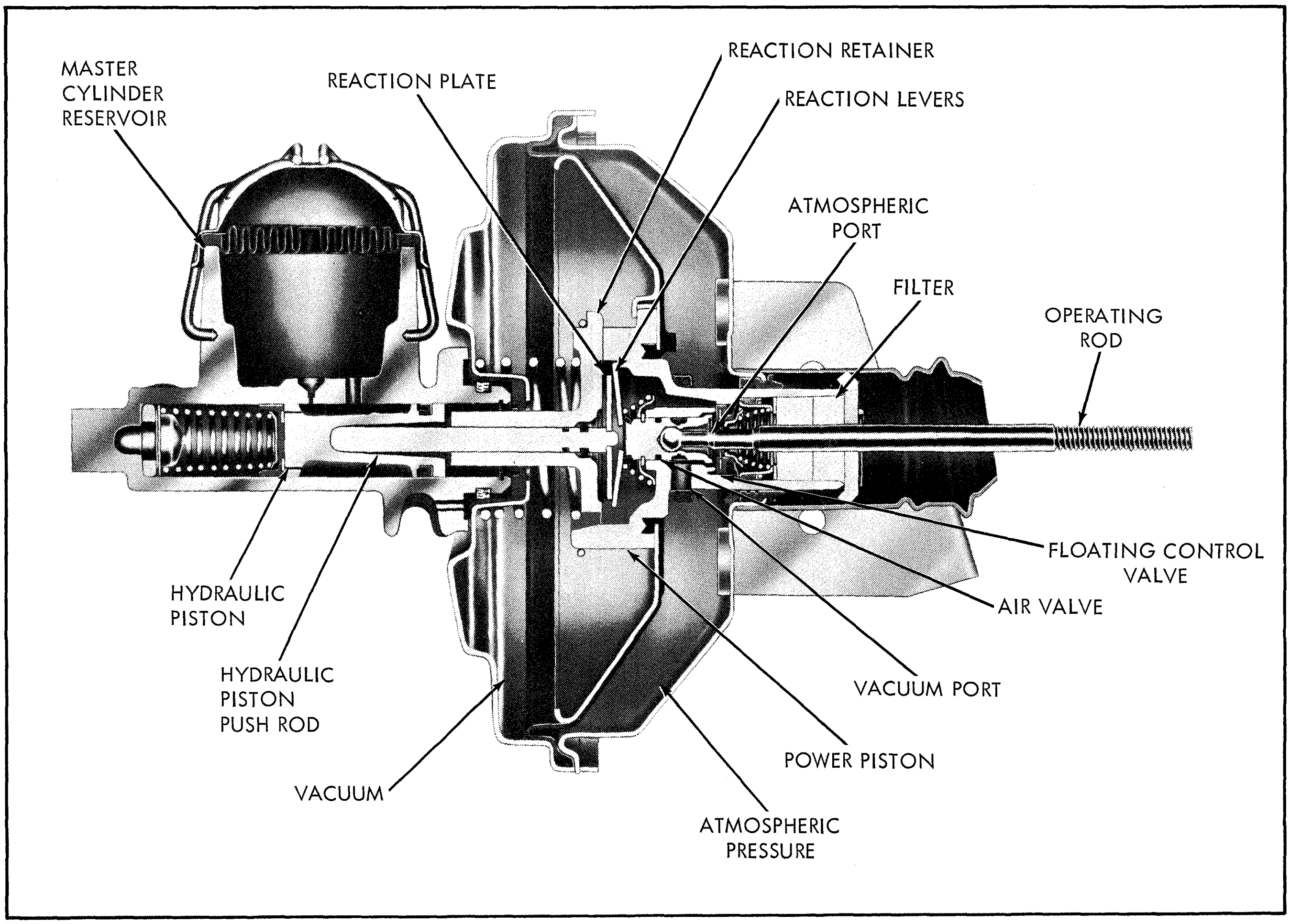



Fig. 5A-2 Applying Position

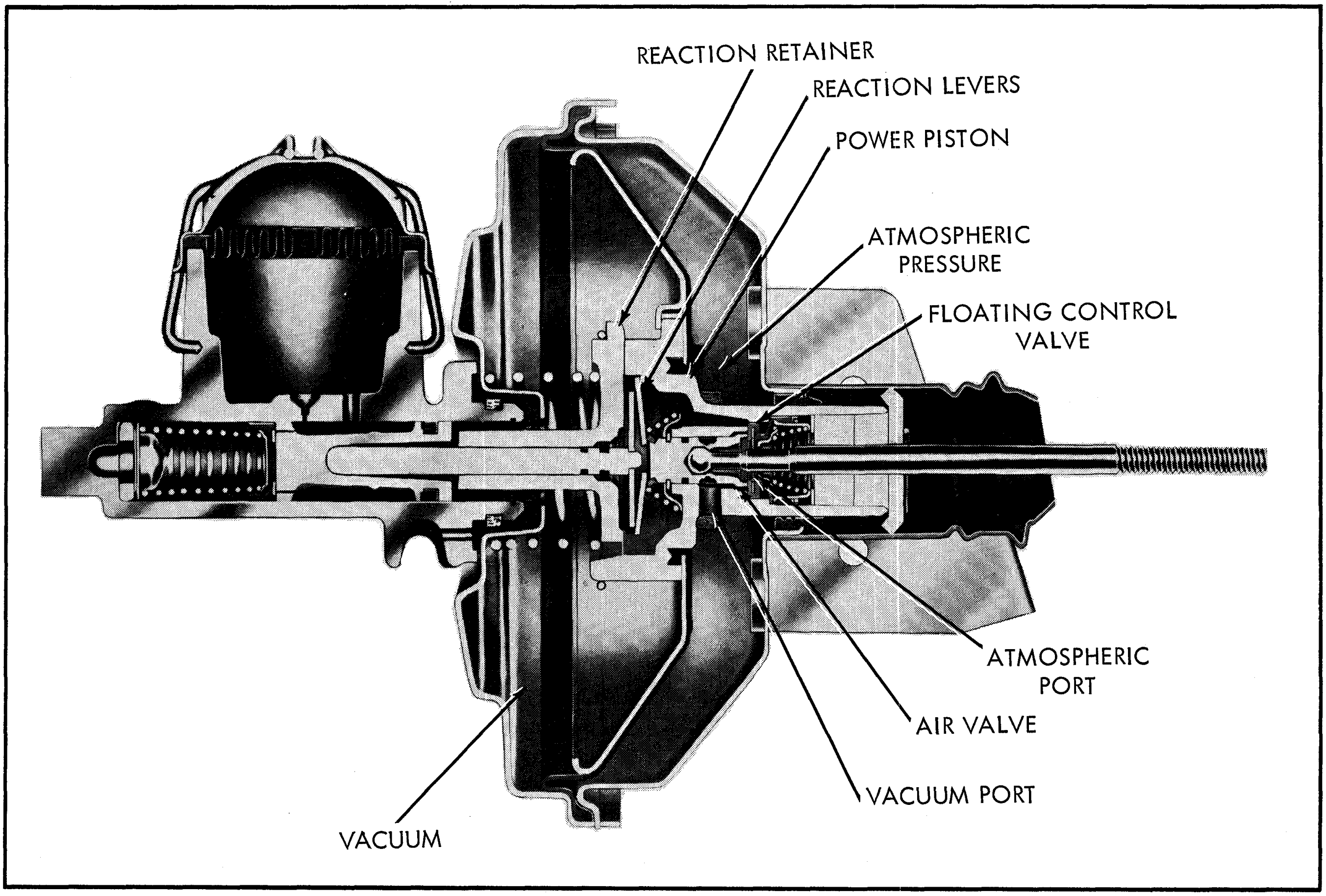



Fig. 5A-3 Holding Position

***RELEASING (Fig. 5A-4)***

As the pressure at the pedal is released, the air valve spring forces the air valve back until its snap ring rests against the power piston. As it returns, the air valve pushes the floating control valve off its seat on the power piston.

The air valve, seating on the floating control valve has shut off the outside air source. When it lifts the floating control valve from its seat on the power piston, it opens the space to the right of the power piston to the vacuum source.

Since both sides of the power piston are now under vacuum, the power piston return spring will return the piston to its released position against the rear housing. As the power piston is returned, the hydraulic master cylinder piston moves back, and the fluid from the wheel cylinders flows back into the master cylinder around the check valve.

If the brake pedal is released quickly, the master cylinder piston immediately returns to the released position. If the fluid in the lines cannot return as quickly as the piston, compensation is provided for by the flow of fluid from the space between the primary cup and the secondary seal through the holes in the piston. The excess fluid in the system can flow back to the fluid reservoir through the small by-pass hole in the master cylinder bore after the brake is released.

***VACUUM FAILURE***

In case of vacuum source interruption, as the pedal is pushed down, the end of the air valve contacts the reaction levers and forces them, in turn, against the hydraulic reaction plate. Since the hydraulic reaction plate is fastened to the piston rod, it forces the piston rod against the master cylinder piston, which builds up the hydraulic line pressure.

The pedal pressure required for a manual application, such as described, is considerably greater than with vacuum-assist.

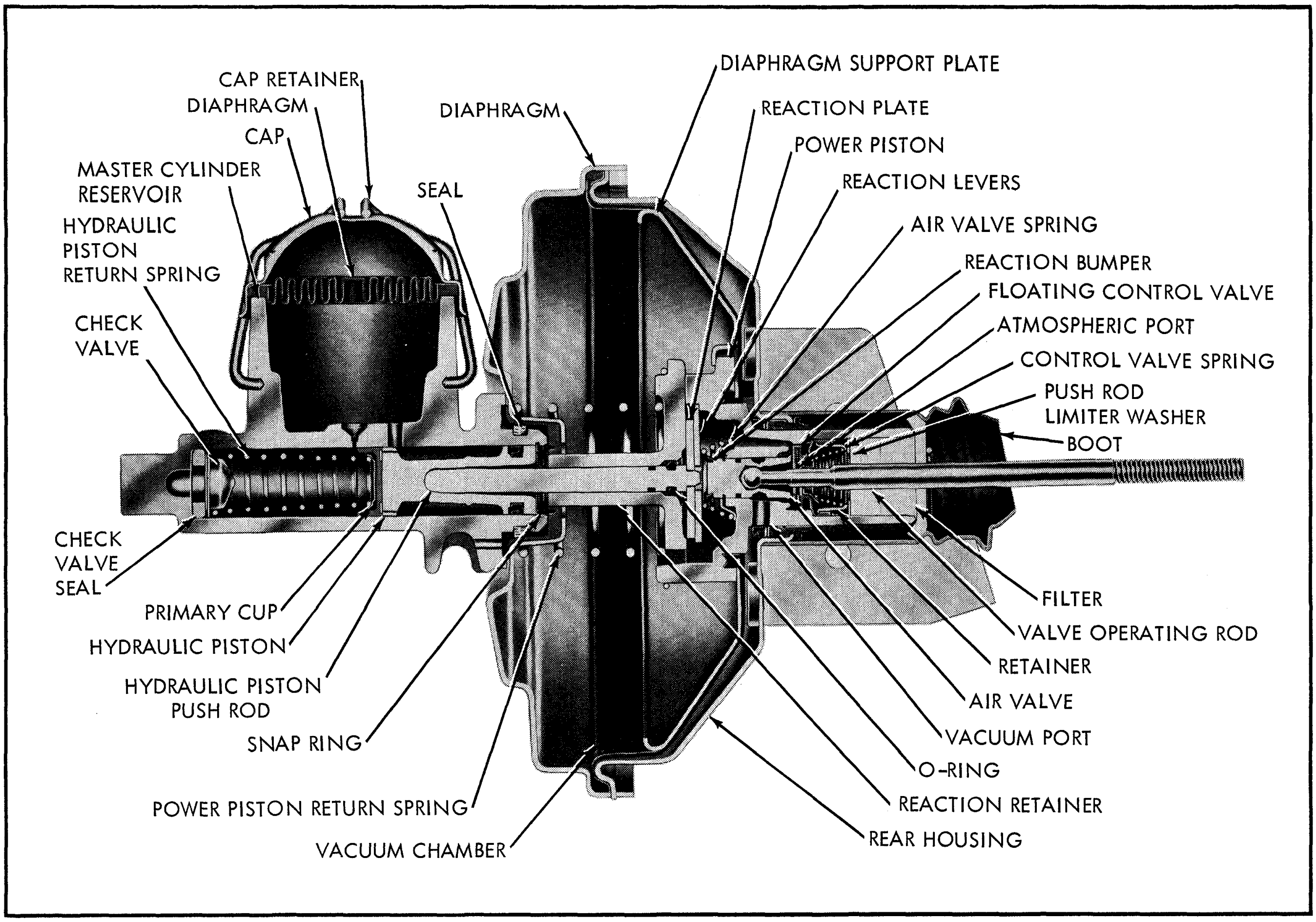



Fig. 5A-4 Releasing

## CHECKS AND ADJUSTMENTS ON CAR

1. Check for free operation of brake pedal. If binding exists, check pivot points for binding and lubricate as required.

2. Check stop light switch for proper setting and operation.

3. Check fluid level in hydraulic cylinder reservoir. Fluid level should be 1/2" from top of filler opening.

4. Check vacuum line and connections between carburetor and vacuum power cylinder for possible vacuum leaks.

5. Check engine for good stall-free idle. Correct as required.

## MINOR REPAIRS

### *BLEEDING BRAKES*

Brakes should be bled in the same manner as standard brakes.

### *STOP LIGHT SWITCH—REMOVE AND REPLACE*

REMOVE

1. Disconnect switch wires by removing plug at stop light switch.

2. Remove switch by screwing out of bracket.

REPLACE

1. Position stop light switch in bracket and screw into maximum distance.

2. Brake pedal arm moves switch to correct distance on rebound. Check if pedal is in full return position by lifting slightly by hand.

3. Connect switch wires by inserting plug on switch.

## OVERHAUL DELCO-MORAINE POWER BRAKE

### *MASTER CYLINDER ONLY—REMOVE*

Certain repair operations, such as replacement of master cylinder internal parts, permits the master cylinder to be removed by itself, leaving the power cylinder, pedal and brackets in the car.

1. Remove hydraulic connection from master cylinder, pump fluid from cylinder into a container and dispose of the fluid. Cover cylinder opening and pipe end to exclude dust, dirt, etc.

2. Remove master cylinder attaching nuts and lockwashers and remove master cylinder from vacuum power section.

### *POWER BRAKE AND MASTER CYLINDER ASSEMBLY—REMOVE*

1. Disconnect vacuum hose at vacuum check valve. Cover hose and valve opening to exclude dust, dirt, etc. (Fig. 5A-5).

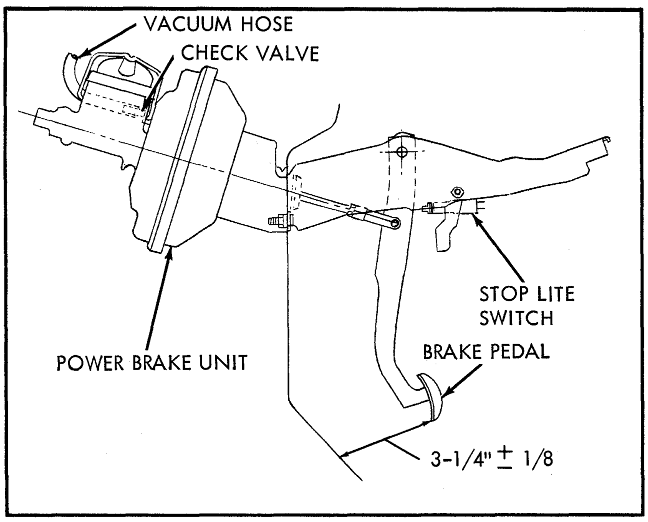



Fig. 5A-5 Simple Schematic of Power Brake System

2. Disconnect pipe from master cylinder hydraulic port and cover cylinder opening and pipe end to exclude dust, dirt, etc.

3. Remove clevis pin from brake pedal inside car.

4. Remove nuts and lockwashers from rear half housing and remove power brake assembly.

5. Clean exterior of power brake asembly and drain reservoir of hydraulic fluid.

### *OVER-ALL BRAKE UNIT—DISASSEMBLE*

1. Put power brake unit in a vise, clamping on sides of master cylinder reservoir with push rod up (Fig. 5A-6).

2. Scribe a line across the front and rear housings to facilitate reassembly.

3. Remove clevis and jam nut from push rod.

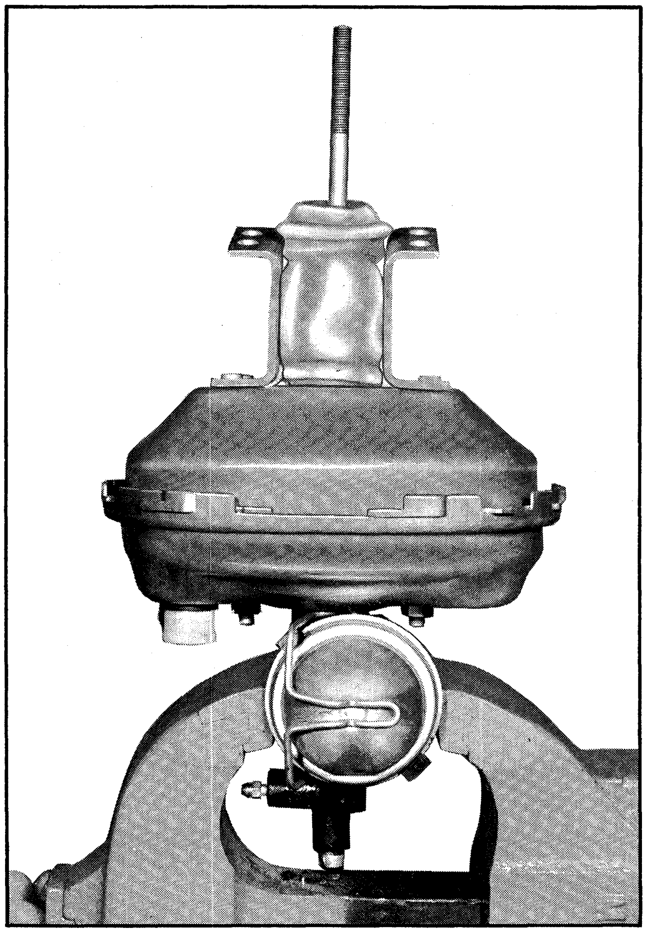


Fig. 5A-6 Brake Unit Mounted in Vise

4. Remove plastic boot and silencer. A small retaining ring on the push rod holds the silencer in place on the push rod.

5. Place a rod in position on rear housing cover and rotate rear half housing counterclockwise to unlock rear half from front housing.

*NOTE: Rotate slowly as housing is under spring load.*

6. Remove rear housing and power piston assembly by lifting straight up slowly and lay it aside on a clean smooth surface (Fig. 5A-7).

7. Remove power piston return spring.

8. Reposition master cylinder in vise. Scribe a line across front housing and master cylinder assembly and remove nuts and lockwashers from master cylinder studs. Remove master cylinder assembly from front housing.

9. Remove front housing seal, vacuum check valve and grommet from front housing (Fig. 5A-8).

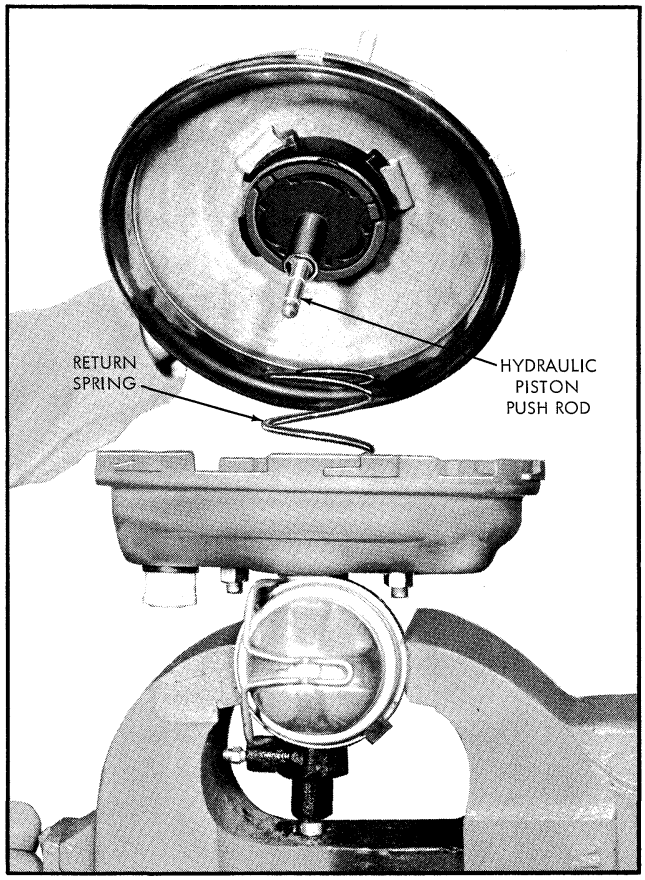



Fig. 5A-7 Removing Rear Housing

### POWER PISTON GROUP—DISASSEMBLE (Fig. 5A-9)

*CAUTION: Care must be taken in handling diaphragm of power piston group. Diaphragm should be guarded against grease, oil and foreign matter and must be protected from nicks or cuts that might be caused by rough surfaces, damaged tools or dropping the piston.*

1. Remove lock ring from power piston by prying from under locking lugs.

2. Remove reaction retainer, piston rod, reaction plate, three reaction levers and air valve spring.

3. Remove small reaction bumper and air valve spring retainer from air valve.

4. Place square end of tool J-21524 in vise holding support plate and power piston with tube end of piston facing up.

5. Pull diaphragm edges away from support plate and position on tool J-21524 so that three lugs on tool fit into three notches in power piston.

6. Press down on support plate and rotate counterclockwise until support plate separates from power piston (Fig. 5A-10).

7. Remove diaphragm from support plate.

8. Remove silencer from neck of power piston tube.

9. Position power piston with tube end down, in vise padded with shop towels.

*CAUTION: Do not clamp on tube as outside surface of tube acts as bearing surface.*

10. Remove snap ring on air valve using Truarc Pliers and place power piston with tube end down in arbor press.

11. Press air valve from power piston using rod not exceeding 1/2 in. diameter. Removal of valve releases floating control valve, floating valve retainer, push rod limiter washer and air filters (Fig. 5A-11).

*NOTE: The floating control valve must be replaced at assembly with a new valve since force required to remove distorts component parts.*

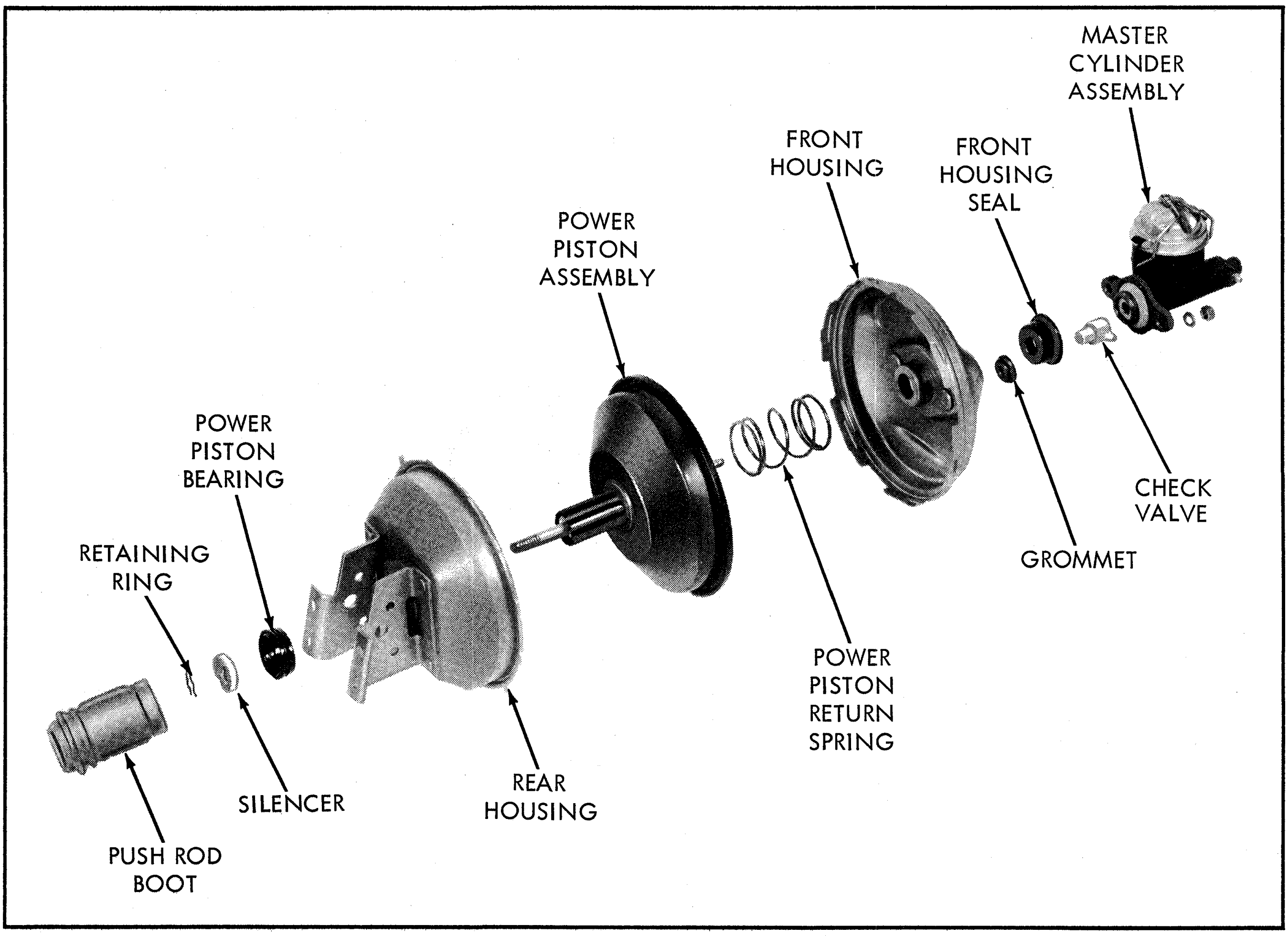



Fig. 5A-8 Power Brake Units - Exploded View

12. Remove master cylinder push rod from center of reaction retainer and two O-rings from grooves in master cylinder piston rod.

#### *MASTER CYLINDER DISASSEMBLE (Fig. 5A-12)*

1. Remove filter from groove on O.D. of open end of master cylinder.

2. Remove lock ring, master cylinder piston assembly, primary cup, spring and retainer, check valve and check valve washer.

3. From master cylinder piston, remove secondary seal. Check small by-pass holes in end of piston to make sure they are open.

4. Remove filler cap from fluid reservoir and remove master cylinder reservoir diaphragm.

## INSPECTION—CLEANING

Thoroughly wash all parts in alcohol and air dry. Blow dust and cleaning fluid out of all internal passages. If inside of front housing is slightly scored or scratched, clean with crocus cloth or fine emery cloth. If scratches in front housing cannot be removed, replace housing.

*CAUTION: It is important that all parts be placed on a clean paper or cloth after being cleaned to prevent the possibility of dirt being assembled into unit or grease contacting any rubber parts.*

#### *POWER BRAKE ASSEMBLY*

Inspect all parts for scoring, pitting, dents or nicks. Small imperfections can be smoothed out with fine emery cloth. Replace if badly nicked, scored or otherwise damaged.

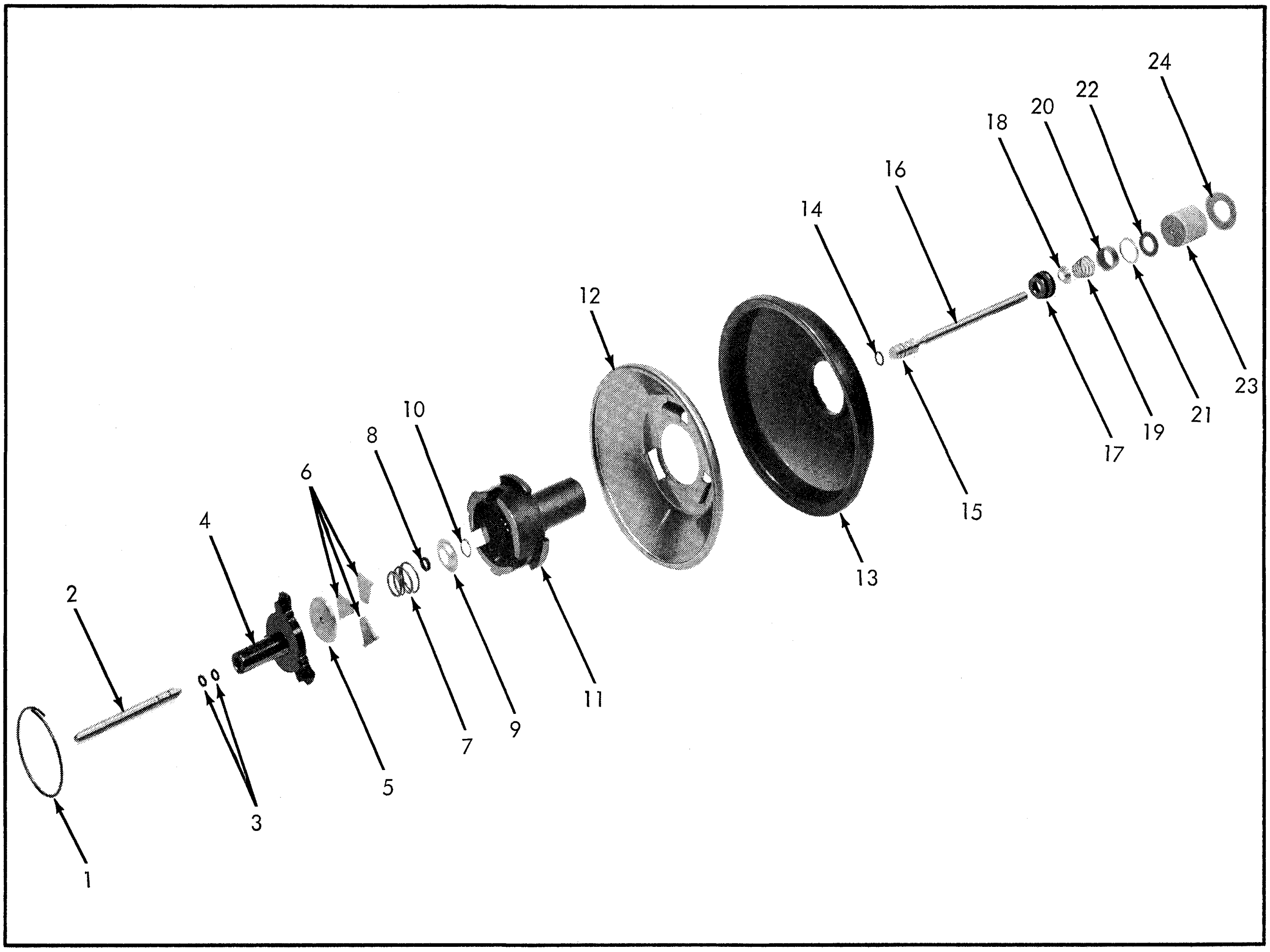



Fig. 5A-9 Power Piston - Exploded View

1. Lock Ring
2. Hydraulic Piston Push Rod
3. "O" Ring Seal
4. Reaction Retainer
5. Reaction Plate
6. Reaction Levers
7. Air Valve Spring
8. Reaction Bumper
9. Retainer, Air Valve Spring
10. Retaining Ring
11. Power Piston
12. Support Plate
13. Diaphragm
14. "O" Ring
15. Air Valve
16. Valve Operating Rod
17. Floating Control Valve
18. Spring Seat
19. Control Valve Spring
20. Floating Valve Spring Retainer
21. Floating Valve Retainer
22. Push Rod Limiter Washer
23. Filter
24. Silencer

### MASTER CYLINDER ASSEMBLY

Inspect bore from the open end. The bore should be free from scores, deep scratches and corrosion. If it appears that corrosive brake fluid has damaged the bore, replace damaged parts and flush out entire brake system including wheel cylinders.

The sealing surfaces should be clean and smooth. Check for cracks and damaged threads. Be sure that the by-pass and compensating ports to the master cylinder are not restricted.

Check for distortion of all springs and deterioration of all rubber parts. Any evidence of soft or swollen rubber parts indicates contaminated brake fluid requiring flushing of the entire brake system and replacement of wheel cylinder cups, as well as all rubber parts in master cylinder.

### AIR FILTER

Replace air filter element if dirty.

## BRAKE ASSEMBLY—ASSEMBLE

### MASTER CYLINDER—ASSEMBLE

1. Install new reservoir diaphragm in reservoir cover, place cover in position and snap on wire bail.

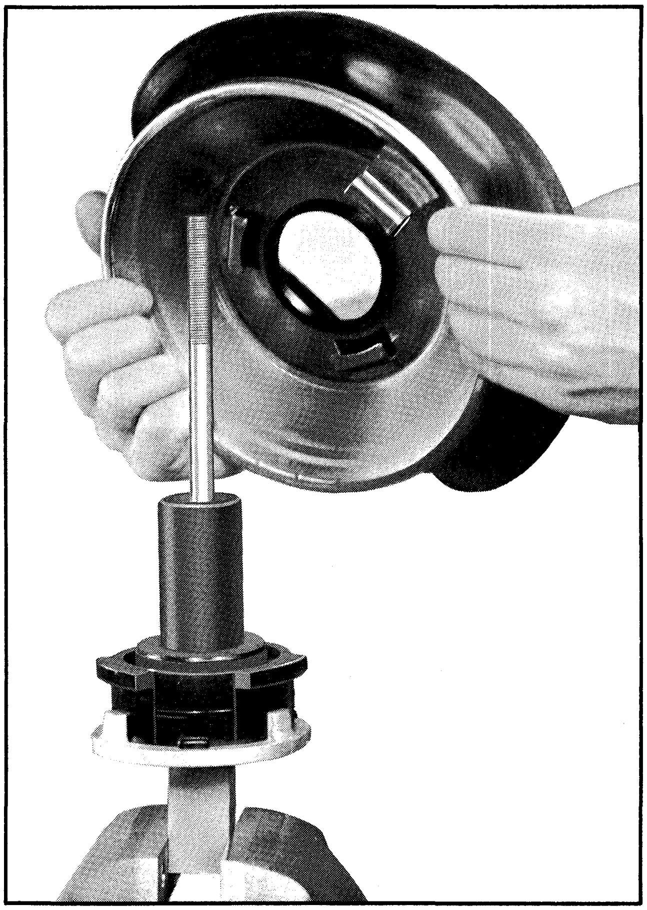


Fig. 5A-10 Removing Support Plate

2. Place master cylinder in vise with open end of bore accessible and position check valve washer in bottom of bore so that it lies flat.

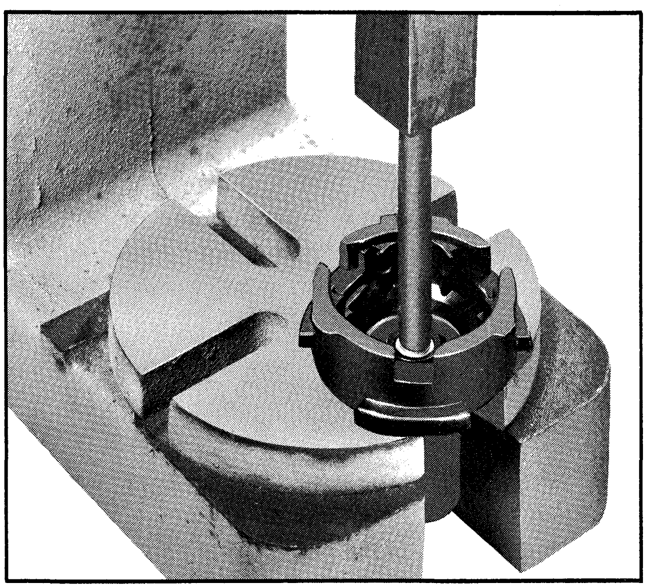


Fig. 5A-11 Removing Air Valve

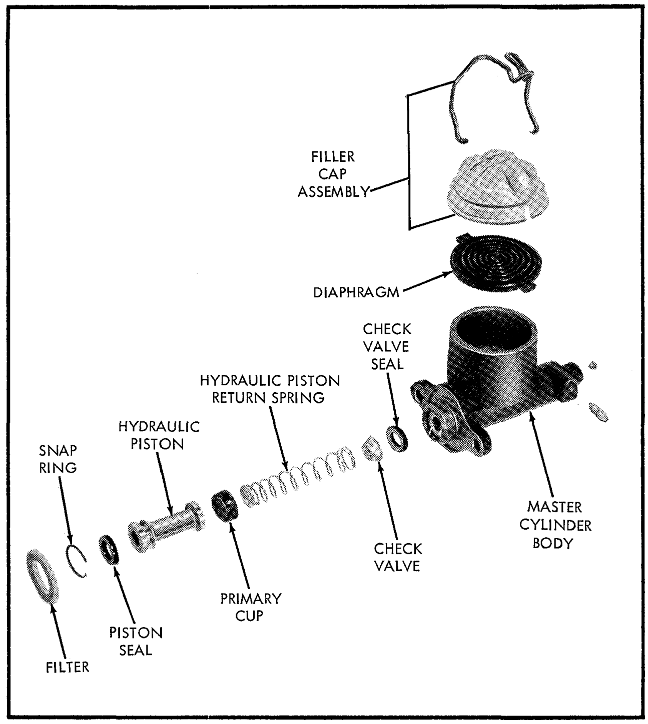



Fig. 5A-12 Master Cylinder - Exploded View

3. Press check valve in open end of spring retainer and position in bore against valve seat washer.

4. Dip primary cup in clean brake fluid and position in bore with lips over spring and retainer assembly.

5. Assemble secondary seal in groove on master cylinder piston so that lip faces toward end of piston which contains small by-pass holes.

6. Press master cylinder piston into bore so that flat end of piston, which contains by-pass holes, lies against flat surface of piston cup.

7. Install snap ring in groove of cylinder.

8. Place a new filter in groove on open end of master cylinder.

9. Position master cylinder on front housing studs and tighten nuts finger tight.

## POWER PISTON—ASSEMBLE

1. Place two new O-rings in grooves on master cylinder piston rod. Wipe thin coat of power brake lubricant on O-rings.

2. Insert piston rod through reaction retainer so that round end of rod protrudes from end of tube on reaction retainer.

3. Place power piston wrench, J-21524 in vise and position power piston on wrench with three lugs fitting into notches in piston.

4. Install new O-ring on air valve in second groove from push rod end.

*NOTE: A new floating control valve must be installed since force required to remove distorts component parts.*

5. Place floating control valve on push rod - air valve assembly, so that flat face of valve will seat against valve seat on air valve.

6. Wipe thin film of power brake lube on large O.D. of floating control valve and on O-ring of air valve.

7. Press air valve - push rod assembly, air valve first, to its seat in tube of power piston.

8. Place floating valve retainer over push rod so that flat side seats on floating control valve.

9. Start floating valve and its retainer into power piston tube. A five inch long piece of 1-1/8" O.D. tubing can be used to press floating valve to seat in tube by placing tubing on top of retainer and pressing down.

10. Position push rod limiter washer over push rod to floating control valve and install two air filter elements over end of push rod and into power piston tube.

11. Assemble power piston diaphragm to support plate from side of plate opposite locking tangs and press raised flange of diaphragm through hole in center of plate.

*NOTE: Be sure that edge of center hole fits into groove in flange of diaphragm.*

12. Pull diaphragm away from O.D. of support plate so that it can be gripped with hands and wipe power brake lubricant on all surfaces of small bead of diaphragm which contacts power piston.

13. Holding support plate on bare metal, with locking tangs down, place support plate and diaphragm assembly down over tube of power piston. Flange of diaphragm will fit into groove on power piston.

14. Press down and rotate support plate clockwise until lugs on power piston come against stops on support plate.

15. Invert assembly and place in padded vise with tube end down and insert snap ring on air valve using Truarc Pliers.

16. Place air valve spring retainer to seat on snap ring and assemble reaction bumper into groove in end of air valve.

17. Position air valve return spring, large end down, on spring retainer.

18. Position three reaction levers in slots on power piston. Narrow ends will rest on top of air valve return spring.

19. Position reaction plate, with numbered side up, on top of reaction levers and press down on plate until large ends of reaction levers pop up so that plate rests flat on levers. Be sure that reaction plate is centered.

20. Place small end of piston rod in hole in center of reaction plate and line up ears on reaction retainer with notches in power piston and push reaction retainer down until ears seat in notches.

21. Maintain pressure on reaction retainer and position large lock ring down over master cylinder push rod so that one end of lock ring goes under lug on power piston raised divider.

*NOTE: Lock ring is positioned around power piston so that it goes alternately over ear of reaction retainer and under lug on power piston until end of ring is seated under lug with raised divider.*

*CAUTION: Make sure that both ends of lock ring are securely under large lug.*

22. Place new front housing seal in center of front housing so that flat surface of cup lies against bottom of depression in housing.

23. Replace vacuum check valve using new grommet if old one is cracked or damaged.

24. Place new power piston bearing in center of rear housing so that flange on center hole of housing fits into groove of power piston bearing. Large flange on power piston bearing will be on stud side of housing.

25. Coat inside of power piston bearing with power brake lube.

26. Place air silencer over holes on tube of power piston and wipe tube with power brake lube.

27. Assemble power piston to rear housing by pushing tube of power piston through rear housing from side opposite studs.

28. Wipe tube of reaction retainer with power brake lube and lay assembly aside.

29. Place front housing in vise with master cylinder down. Position power piston return spring over inset in front housing. Lubricate I.D. of support plate seal with power brake lube.

30. Lubricate beaded edge of diaphragm lightly with talcum powder. Hold rear housing and power piston assembly over front housing with master cylinder push rod down and position rear housing so that scribe marks on housings will be in line when it is rotated into locked position.

31. Place rod in position on rear housing. Press down to check that bead of diaphragm is positioned between edges of housings. If this is satisfactory, apply additional pressure on rear housing and, at the same time rotate housing clockwise into locked position. If housings are not easily locked, hold housing together and apply vacuum to check valve in front housing. This will draw housings together and will ease locking procedure.

*CAUTION: Do not put pressure on power piston tube when locking housings and be careful not to break studs in rear housing.*

32. Push felt silencer over push rod to seat against end of power piston tube and place snap ring retainer on push rod to hold silencer against power piston tube.

33. Seat plastic boot against rear housing. Raised humps on side of boot will locate in large holes in center of brackets. Install jam nut and clevis on push rod.

### PUSH ROD ADJUSTMENT

1. Place power brake assembly in vise so that master cylinder is up. Remove master cylinder from front housing. Master cylinder push rod is now exposed.

2. Place gauge J-7723 over piston rod so that it fits between the two studs on front housing (Fig. 5A-13). It should be parallel to studs and resting on surface of housing. Cutout portion of gauge should never be lower than end of piston rod, and gap between cutout in gauge and end of piston rod should never be more than 0.010 inch.

*NOTE: Any variation beyond these two limits must be compensated for by obtaining service adjustable piston rod and adjusting screw in end to match height of gauge.*

3. Replace master cylinder on front housing studs. Install lockwashers and nuts on studs. Torque to 15-20 lb. ft.

*CAUTION: After replacing unit on vehicle start engine and allow vacuum to build up before applying brakes.*

## POWER BRAKE ASSEMBLY—INSTALL

1. Place power brake into position and install four rear housing to dash attaching lockwashers and nuts from inside of car. Tighten nuts 20-35 lb. ft. torque.

2. Attach clevis to brake pedal assembly and adjust pedal to height to provide 3-1/8" to 3-3/8" clearance from floor mat to bottom of pedal pad. Secure clevis lock nut and tighten 5-10 lb. ft. torque.

3. See page 5A-6 for stoplight switch adjustment.

4. Attach vacuum line.

5. Attach hydraulic line.

6. Bleed brakes as necessary and fill fluid reservoir to provide a distance of 1/2" from top of filler hole.

### SYSTEM TESTS

Road test the brakes by making a brake application at about 20 MPH to determine if the vehicle stops

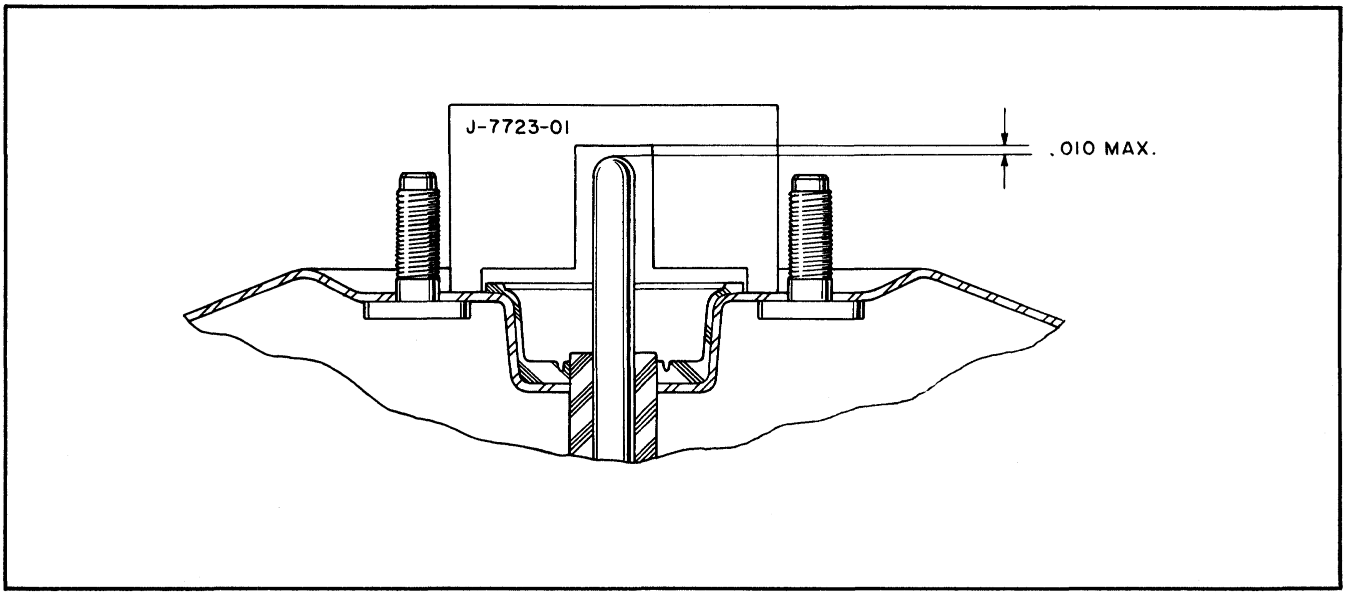



Fig. 5A-13 Checking Master Cylinder Push Rod Adjustment

evenly and quickly. If the pedal has a spongy feel when applying the brakes, air may be present in the hydraulic system and bleeding of brakes may be required.

When the engine is stopped and the transmission is in neutral, apply brakes several times to deplete all vacuum reserve in the system. Depress brake pedal, hold light-foot pressure on the pedal, and start the engine. If the vacuum system is operating, the pedal will tend to fall away under foot pressure, and less pressure will be required to hold pedal in applied position. If no action is felt, the vacuum system is not functioning.

Stop engine and deplete all vacuum reserve in the system. Depress the brake pedal and hold foot pressure on the pedal. If the pedal gradually falls away under foot pressure, the hydraulic system is leaking.

If the brake pedal travels to within one inch of the toe-board, the brake shoes require adjustment or relining.

Start engine with brakes off, run to medium speed and turn off the ignition. Immediately close the throttle to build up vacuum. Wait at least 90 seconds, then try brake action. If not vacuum-assisted for two or more applications, vacuum check valve is faulty or leak exists in vacuum system.

## TROUBLE DIAGNOSIS

The same types of brake trouble are encountered with power brakes as with standard brakes. Before checking the power brake system for the source of trouble, refer to the trouble diagnosis of standard brakes in the shop manual. After these possible causes have been eliminated, check for the cause as outlined below:

HARD PEDAL

(a) Vacuum failure due to:

1. Faulty vacuum check valve.

2. Collapsed vacuum hose to manifold.

3. Plugged or loose vacuum fittings.

(b) Tight pedal linkage

(c) Power brake unit trouble

1. Jammed air valve.

2. Vacuum leaks in unit caused by: faulty air valve seal or support plate seal. Also, a damaged, floating control valve, faulty seal of master cylinder, or power cylinder mounting studs in housings, faulty seal on master cylinder push rod or a faulty seal of the diaphragm bead between the

housings, or at power piston. It is also possible to have faulty vacuum check valve grommet.

3. Defective rolling diaphragm.

4. Restricted air filter elements.

5. Worn or badly-distorted reaction plate or levers.

6. Cracked or broken power piston or reaction retainer.

GRABBY BRAKES (APPARENT OFF-AND-ON CONDITION)

(a) Power brake unit valve trouble.

1. Sticking air valve.

2. Restricted diaphragm passage.

(b) Reaction system.

1. Dislodged reaction levers.

2. Broken air valve spring.

3. Worn or distorted levers or plates.

PEDAL GOES TO THE FLOOR OR ALMOST TO THE FLOOR

(a) Fluid reservoir needs replenishing.

(b) Power brake hydraulic system leakage.

1. Defective primary or secondary cups.

2. Cracked master cylinder casting.

3. Leaks at wheel cylinder, in pipes, at hoses or connections.

(c) Faulty master cylinder check valve has permitted air to enter system, causing spongy pedal.

BRAKES FAIL TO RELEASE

(a) Faulty hydraulic check valve.

(b) Blocked passage in power piston.

(c) Air valve sticking.

(d) Broken piston return spring.

(e) Broken air valve spring.

(f) Tight pedal linkage.

## TORQUE SPECIFICATIONS

| | Lb.-Ft. |
|---|---|
| Power Cylinder Housing-to-Master Cylinder Nuts | 15-20 |
| Rear Housing to Dash Nuts | 15-25 |
| Clevis Lock Nut | 5-10 |

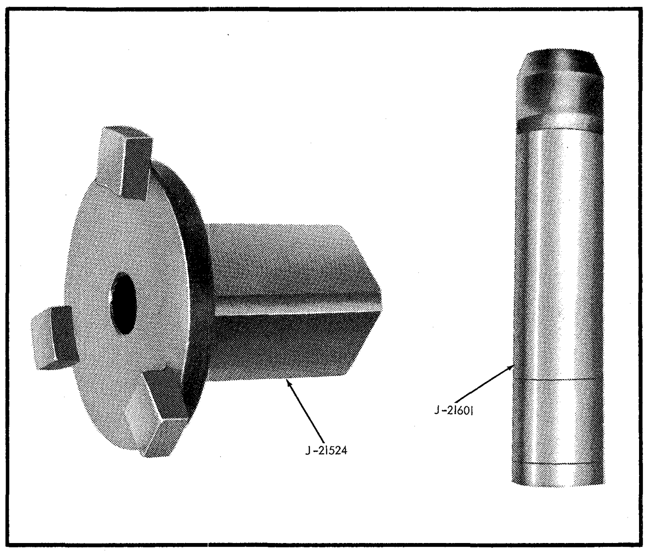



Fig. 5A-14 Special Tools

# ENGINE MECHANICAL

## CONTENTS OF THIS SECTION—SIX CYLINDER ENGINE
FOR CONTENTS OF V-8 ENGINE SEE PAGE 6-41



| Engine Code | Horse-Power* | Trans. Type | Model | Application | Comp. Ratio | | Carb. | | | Valve Spring | | | Spec. Lifter | Camshaft Ident. No. | | Distributor | | H.D. Clutch |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 8.6 | 10.5 | 1-bbl. | 2-bbl. | 4-bbl. | Single | Two | H.D. | | 3788506 | 537441 | 1110293 | 1111039 | |
| 80Z | 140 | SM | 215 | Standard | X | | X | | | X | | | | X | | X | | |
| 84Z | 140 | SM | 215 | Taxi | X | | X | | | X | | | | X | | X | | X |
| | | | | Spec. Equip. | X | | X | | | X | | | | X | | X | | X |
| | | | | Trail. Prov. | X | | X | | | X | | | | X | | X | | X |
| 88Y | 140 | Auto. | 215 | Standard | X | | X | | | X | | | | X | | X | | |
| 92X | 250 | SM | 326 | Spec. Equip. | X | | | X | | | X | | | | X | | X | |
| 94X | 280 | SM | 326HO | Spec. Equip. | | X | | | X | | | X | X | | X | | X | |
| 96O | 250 | Auto. | 326 | Spec. Equip. | X | | | X | | | X | | | | X | | X | |
| 97O | 280 | Auto. | 326HO | Spec. Equip. | | X | | | X | | | X | | | X | | X | |

Transmission Code
Z-Synchromesh (3 Speed) (215 Engine)
X-Synchromesh (3 Speed) (326 Engine)
Y-Automatic (215 Engine)
O-Automatic (326 Engine)

Fig. 6-1 Tempest Engine Chart

## GENERAL DESCRIPTION

The Pontiac Tempest uses a 215 cubic inch, in-line, overhead valve six cylinder engine as standard equipment. This engine has a 3-3/4" bore and 3-1/4" stroke. The compression ratio of this engine is 8.6:1.

Two optional V-8 engines with 326 cubic inch displacement are available on special order. These engines have a 3-23/32" bore and 3-3/4" stroke. The compression ratios are 8.6:1 and 10.5:1.

Seven different engine combinations are available. These combinations and their usage are shown on the engine chart (Fig. 6-1).

Engine identification is facilitated by a number-letter code stamped below the production engine number. By referring to the identification code and Fig. 6-1 each engine may be readily identified.

The engine code for 6 cyl. engines is stamped on the distributor mounting pad at the right side of block. On V-8 engines the code is stamped on the block in front of the right bank of cylinders.

The V-8 engine (Fig. 6-2 and 6-3) features a completely machined combustion chamber. Both the 6 cyl. and V-8 engines have overhead valves, ball pivot rocker arm construction, harmonic balancer, hydraulic lifters, aluminum pistons, straight valve guides, superior crankcase ventilation and lubrication systems, and large displacement combined with high compression ratio for most favorable performance and economy.

Detailed descriptions of cooling, crankcase ventilation, and the lubrication system are given in ENGINE COOLING AND LUBRICATION, Section 6A.

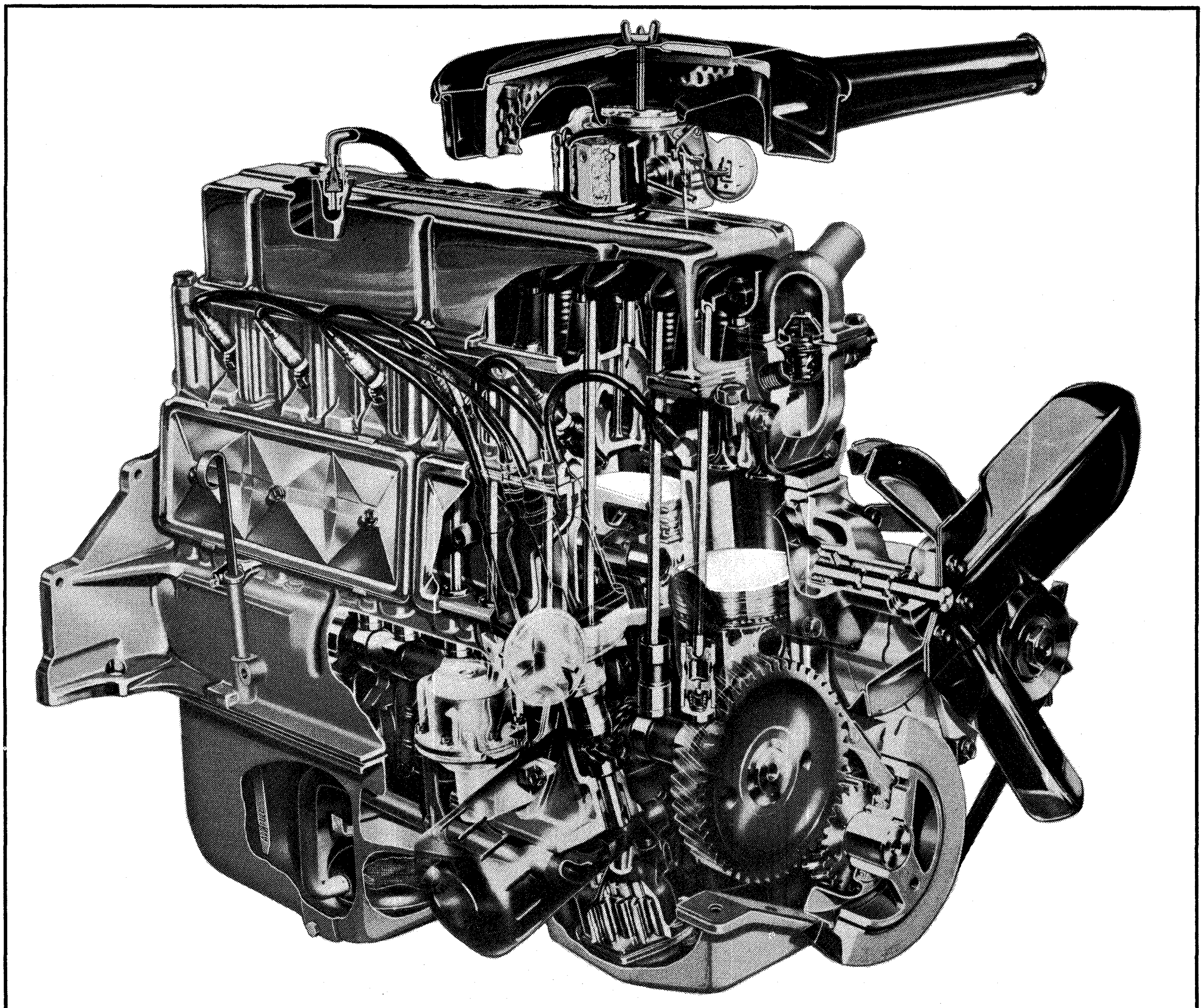


Fig. 6-2 Tempest 215 Cu. In. 6-Cyl. Engine

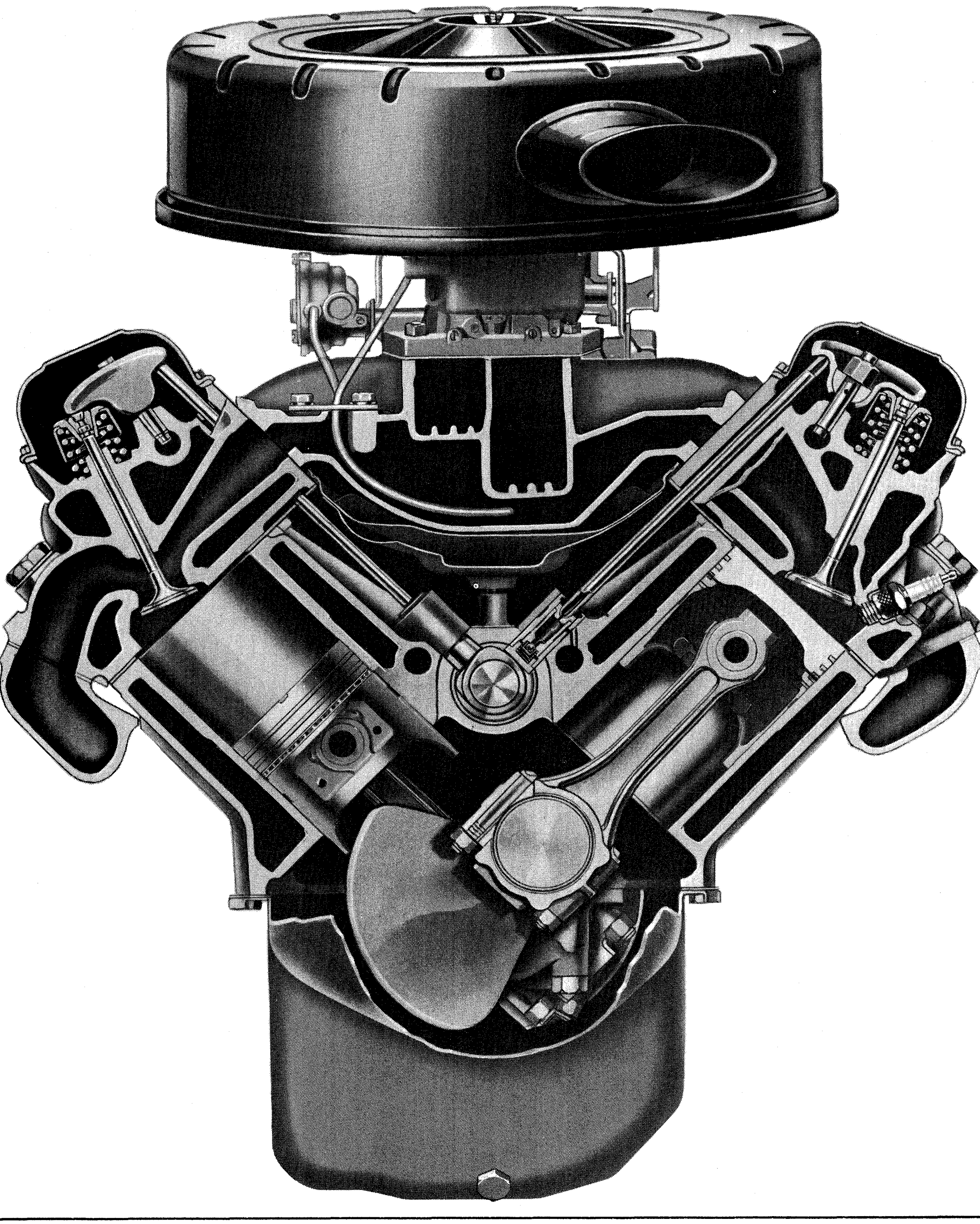


Fig. 6-3 Tempest 326 Cu. In. V-8 Engine

# SIX CYLINDER ENGINE

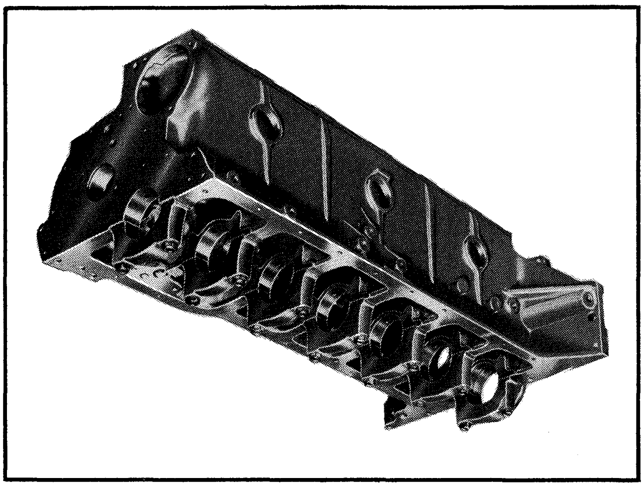


Fig. 6-4 Cylinder Block and Bearing Caps

## GENERAL DESCRIPTION

### *CYLINDER BLOCK*

The cast iron cylinder block has one vertical row of six cylinders numbered from front to rear, 1 through 6. Seven main bearings support the crankshaft (Fig. 6-4). Bearing caps fit in recesses in the block which assure accurate alignment and facilitate assembly.

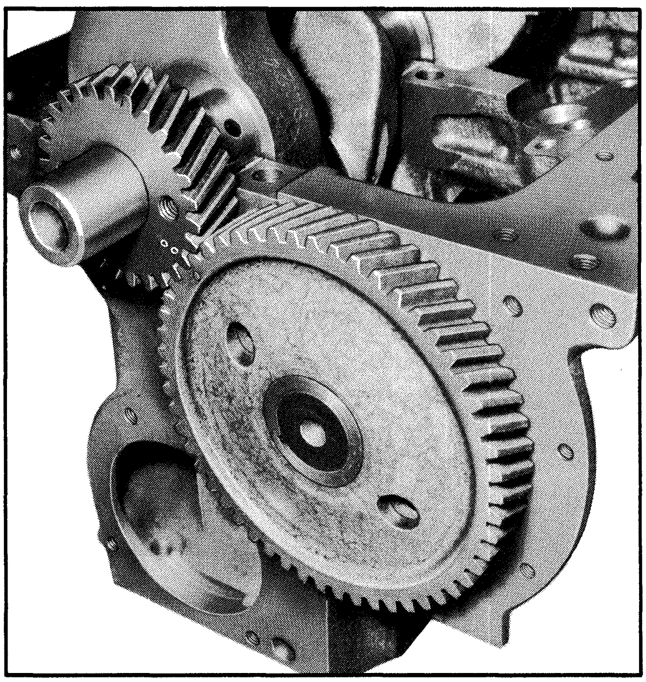


Fig. 6-5 Timing Gears

Cylinders are completely encircled by coolant jackets. For details of engine cooling system see ENGINE COOLING AND LUBRICATION.

### *CYLINDER HEADS*

The cast iron cylinder head provides a compression ratio of 8.6:1.

Two large coolant ports at the rear end of the cylinder head provide coolant to passages beneath each spark plug. Coolant surrounds each spark plug mounting and valve seat. Coolant returns to the water pump through an outlet at the front of the cylinder head.

Oil is fed through hollow push rods to the upper valve train for superior lubrication.

### *CRANKSHAFT AND BEARINGS*

The crankshaft is cast nodular iron and is supported by seven main bearings.

Main bearings are lubricated from oil holes which intersect the main oil gallery which runs parallel to the cylinder bores along the right side of the block.

A rubber floated harmonic balancer on the forward end of the crankshaft dampens any engine torsional vibrations.

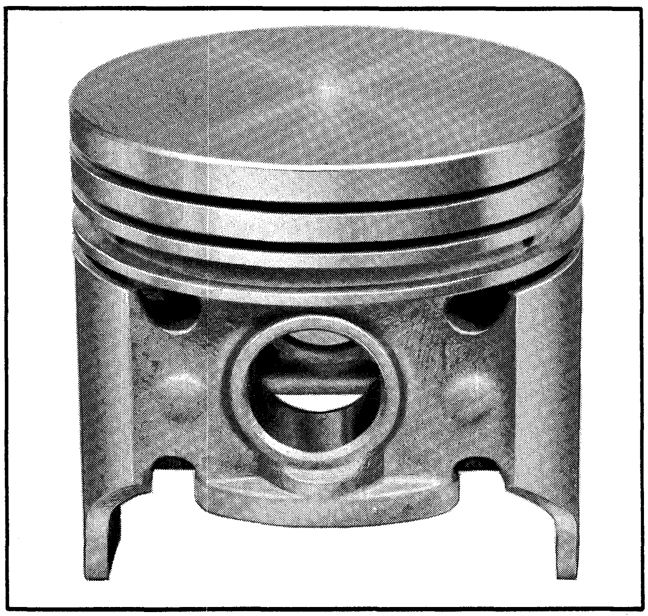


Fig. 6-6 Piston

### CAMSHAFT AND DRIVE

The cast iron camshaft is supported by four bearings and is gear driven. A steel crankshaft gear drives the camshaft through a bakelite fabric composition gear with steel hub (Fig. 6-5).

Cam lobes are ground, hardened and tapered with the high side toward the rear. This coupled with a spherical face on the lifter causes valve lifters to rotate.

Camshaft bearings are lubricated through oil holes which intersect the main gallery. The main gallery runs parallel to the cylinder bores along the right side of the block.

### PISTONS AND CONNECTING RODS

The pistons are aluminum alloy, tin plated, with steel struts to control expansion and give added strength (Fig. 6-6). Pistons are cam ground so that the diameter across the thrust faces is larger than the diameter fore and aft of the engine. The steel struts force expansion and contraction to occur to the front and rear and thus provides a constant diameter across the thrust faces. Two compression rings and one oil control ring are used, all of which are located above the piston pin.

All pistons are flat on top as shown in Fig. 6-5.

Piston pins are offset 1/16" toward thrust side (right hand side) to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path. This feature provides quieter engine operation. Pins are hardened steel and have a floating fit in the pistons. They are retained in the connecting rods by a press fit.

Connecting rods are made of forged steel. Full pressure lubrication is directed to the connecting rods by drilled oil passages from and adjacent main bearing journal. Oil holes at the connecting rod journals are located so that oil is supplied to give maximum lubrication just prior to full bearing load.

### VALVE TRAIN

A very simple ball pivot type train is used (Fig. 6-7). Motion is transmitted from the camshaft through the hydraulic lifter and push rod to the rocker arm. The rocker arm pivots on its ball and transmits the camshaft motion to the valve. The rocker arm ball is retained by a nut.

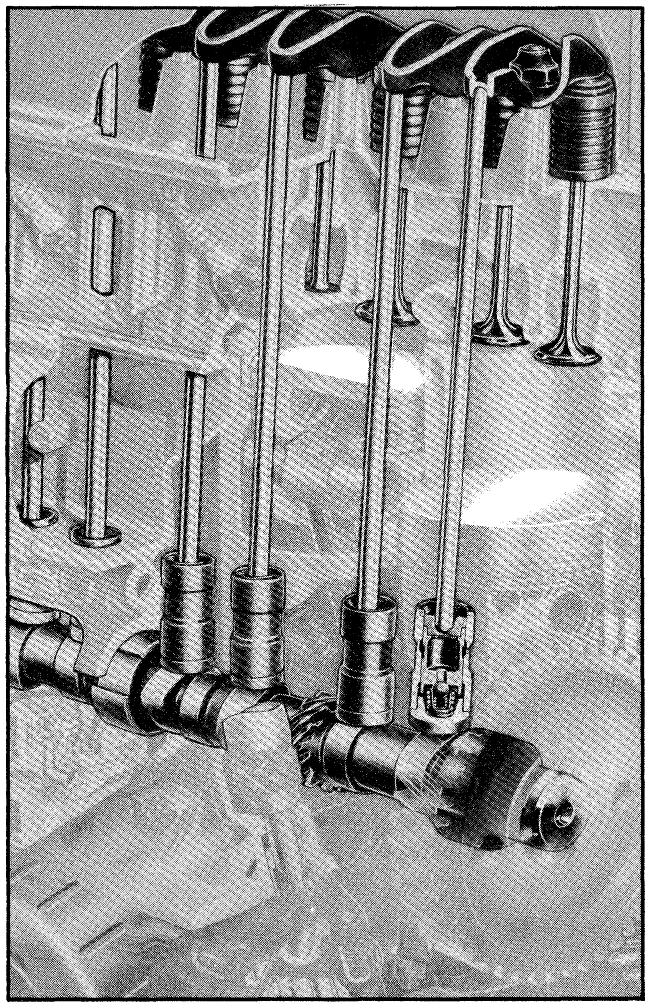


Fig. 6-7 Valve Train

The maximum in durability is assured by the use of carbo-nitrided, stamped steel rocker arms. In addition all friction points to the valve train are positively lubricated.

The cylinder head has straight valve guides cast integrally (Fig. 6-7). External shields are used on both intake and exhaust valves to reduce the amount of oil splashed against stems. Valve stem seals are used on exhaust as well as intake valves to prevent oil from entering the valve guides.

A single valve spring is used.

### HYDRAULIC VALVE LIFTERS

Hydraulic valve lifters are used to keep all parts of the valve train in constant contact.

The hydraulic lifter assembly (Fig. 6-8) includes: the cast iron body which rides in the cylinder block

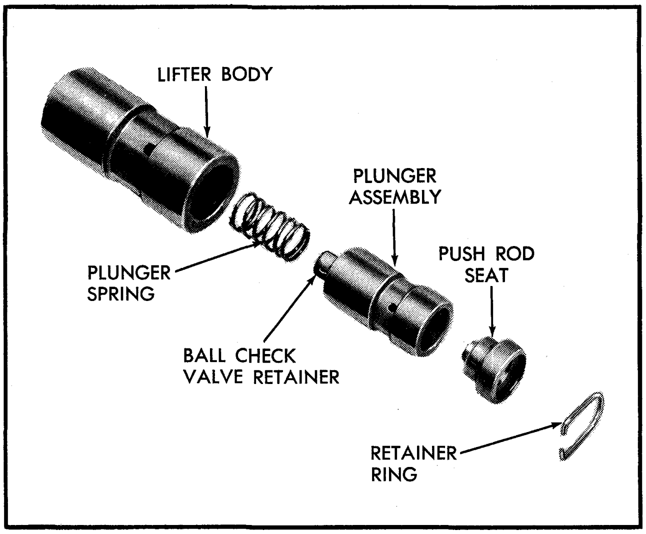



Fig. 6-8 Hydraulic Valve Lifter

boss, the plunger, push rod seat, metering valve, plunger spring, ball check valve, ball check valve retainer, and retainer ring.

The hydraulic valve lifter functions as follows: when the lifter is riding on the low point of the cam, the plunger spring keeps the plunger and push rod seat in contact with the push rod.

When the lifter body begins to ride up the cam lobe, the ball check valve cuts off the transfer of oil from the reservoir below the plunger. The plunger and lifter body then rise as a unit pushing up the push rod and opening the valve.

As the lifter body rides down the other side of the cam the plunger follows with it until the valve closes.

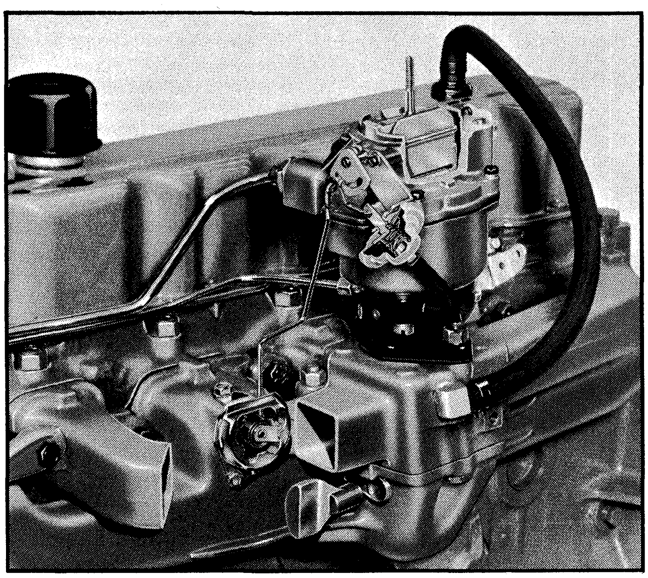


Fig. 6-9 Carburetor and Intake Manifold

The lifter body continues to follow the cam to its low point, but the plunger spring keeps the plunger in contact with the push rod. The ball check valve will then move off its seat and the lifter reservoir will remain full.

During operation a small amount of oil leaks out of the lifter between the plunger and body. A controlled amount of leakage is important to provide continuous adjustment of the plunger position within the lifter. This leakage is called "leak down" and must be within certain limits to provide correct operation (see page 6-15).

Oil is supplied to the lifter by the cylinder block oil gallery to replace that lost through leak down. The annular groove around the outside of the lifter body indexes with the passage drilled from the gallery to the lifter boss. Oil then enters the lifter from this groove and passes into the plunger cavity. From the plunger cavity, oil under pressure is also fed up the push rod to lubricate the friction area between the upper end of the push rod and the rocker arm and other upper valve train contact points.

## *FUEL DISTRIBUTION SYSTEM (Fig. 6-9)*

A single barrel carburetor with an automatic choke provides fuel to the intake manifold.

The intake manifold is positioned directly above the exhaust manifold (Fig. 6-10). This design allows hot exhaust to heat the cool, incoming fuel mixture.

The side-by-side location of the intake valves and side-by-side location of the exhaust valves along with joined parts permit the use of a three port intake manifold and four port exhaust manifold (Fig. 6-10).

## *EXHAUST SYSTEM*

The four-port, cast iron exhaust manifold contains a heat riser valve. This thermostatically controlled

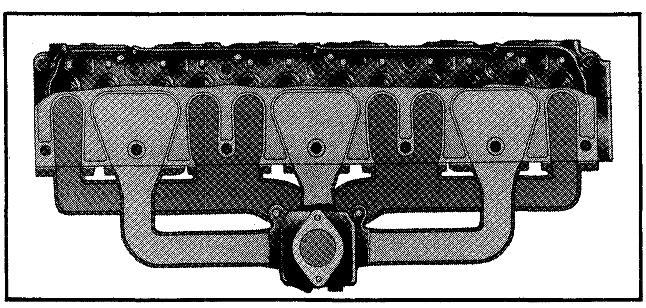


Fig. 6-10 Intake and Exhaust Manifolds

valve is located above the manifold to exhaust pipe outlet. When the engine is cold this valve closes, blocking the exhaust outlet thus causing the hot exhaust to warm the stove beneath the carburetor. The fuel mixture is warmed by passing above through the stove. The heat riser valve opens as the engine warms up.

### *COMBUSTION CHAMBERS*

Combustion chambers are cast to insure uniform shape for all cylinders. Spark plugs are located near intake valves for maximum power and to properly fire economically lean mixtures.

The contoured wedge shape of the combustion chamber (Fig. 6-11) minimizes the possibility of detonation, facilitates breathing and provides swirling turbulence for smooth, complete combustion.

Intake valves are large and have 46° seat angles to further provide easy breathing for high combustion efficiency. Exhaust valve seat angle is also 46°.

## GENERAL INFORMATION ON ENGINE SERVICE

Cleanliness is a primary factor when servicing the engine. The slightest particle of dirt that finds its way into a hydraulic lifter may cause a malfunction.

Since any dirt which may enter the oil galleries or passages in the engine could eventually get to a

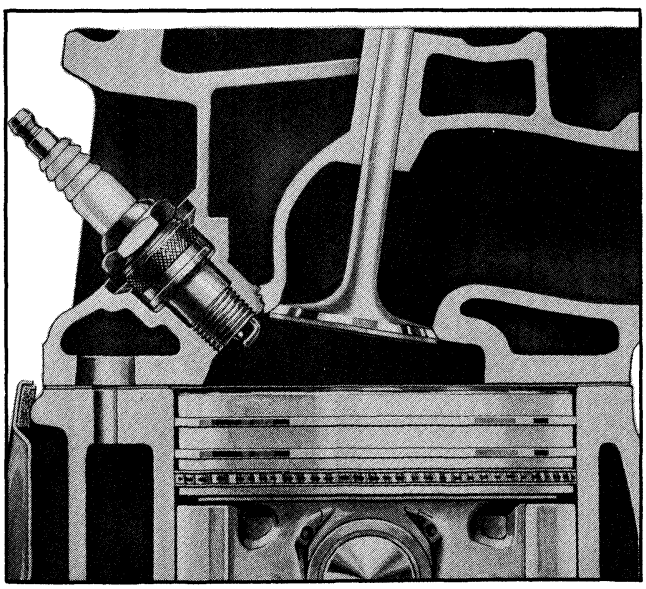


Fig. 6-11 Combustion Chamber

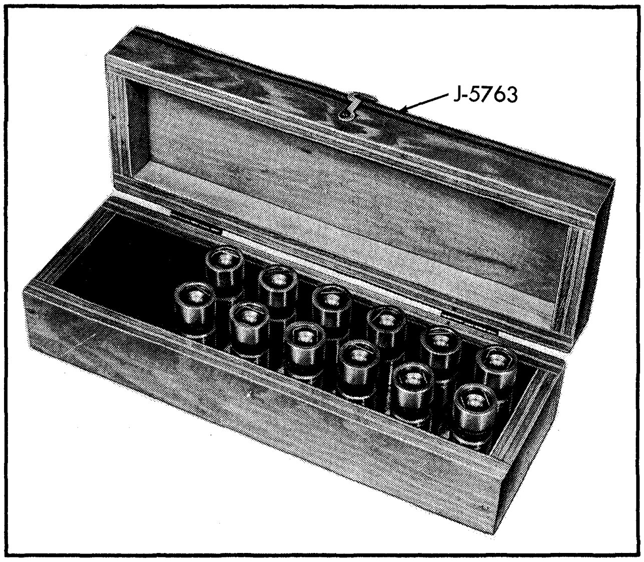



Fig. 6-12 Valve Lifter Storage Box

lifter, cleanliness should be exercised when any part of the engine is removed or disassembled. When a cylinder head is removed for any purpose, it is necessary to remove the push rod cover. This exposes the lifters to any dirt which may fall from the upper portion of the block or which may be carried in the air. Thus, it is wise to cover the lifter galleries until ready to reassemble the engine.

When lifters are removed for any reason, they should immediately be placed in order in valve lifter storage box J-5763 (Fig. 6-12). This is important for two reasons. First, it is the easiest way to keep lifters clean. Second, lifters should always be replaced in the same bosses from which they were removed.

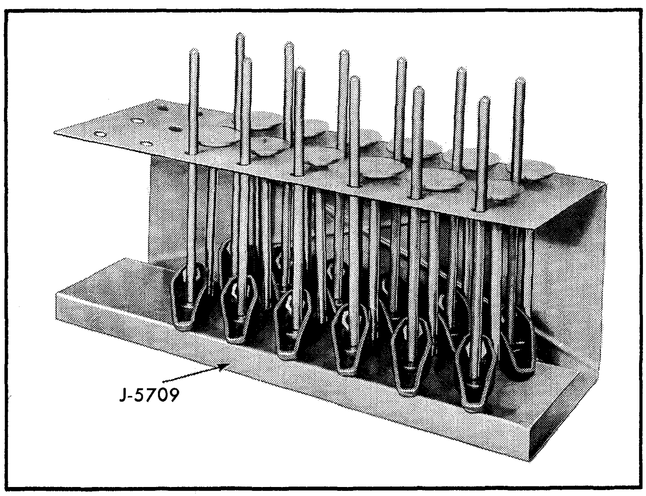



Fig. 6-13 Valve and Valve Train Holding Stand

Valves, valve lifters, push rods, rocker arms, rocker arm balls, and rocker arm ball nuts should always be kept in sets and returned to their original positions. These parts will tend to mate as the engine operates and will provide more satisfactory operation when kept together. By storing lifters in storage box J-5763 and valves, push rods, rocker arms, balls and nuts in holding stand J-5709 (Fig. 6-13), whenever they are removed, they can easily be kept in sets for identification during assembly. In addition to keeping the parts in sets, the push rods should be replaced with the same end up. In other words, the same end will contact the rocker arm as before the engine was disassembled. The upper end can usually be identified by the polished surface which contacts the rocker arm. Push rods will also be polished somewhat in the area where the rod passes through the head.

When hydraulic valve lifters are disassembled, the various parts of each lifter must be kept together. This is especially important since the lifter body and plunger are selectively fitted. The use of the special tray included with cleaning tank J-5821 will aid in keeping the parts of each lifter together when lifters are being serviced.

When raising or supporting the engine for any reason, do not use a jack under the oil pan or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, the result would be a telegraphed noise which would be difficult to trace.

It should be kept in mind, while working on the engine, that the twelve volt electrical system is capable of violent and damaging short circuits. When performing any work where electrical terminals could possibly be grounded, the ground cable of the battery should be disconnected.

Any time the carburetor or air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material which could follow the intake passage into the cylinder and cause extensive damage when the engine is started.

In the mechanical procedures described in this section generally no references will be made to the removal of optional equipment such as power steering pump, air conditioning compressor, etc.

Should it become necessary to remove any such item to perform other service refer to the appropriate section of the manual for specific information.

## PERIODIC SERVICE

There are no periodic services required on the mechanical portions of the engine. Periodic services

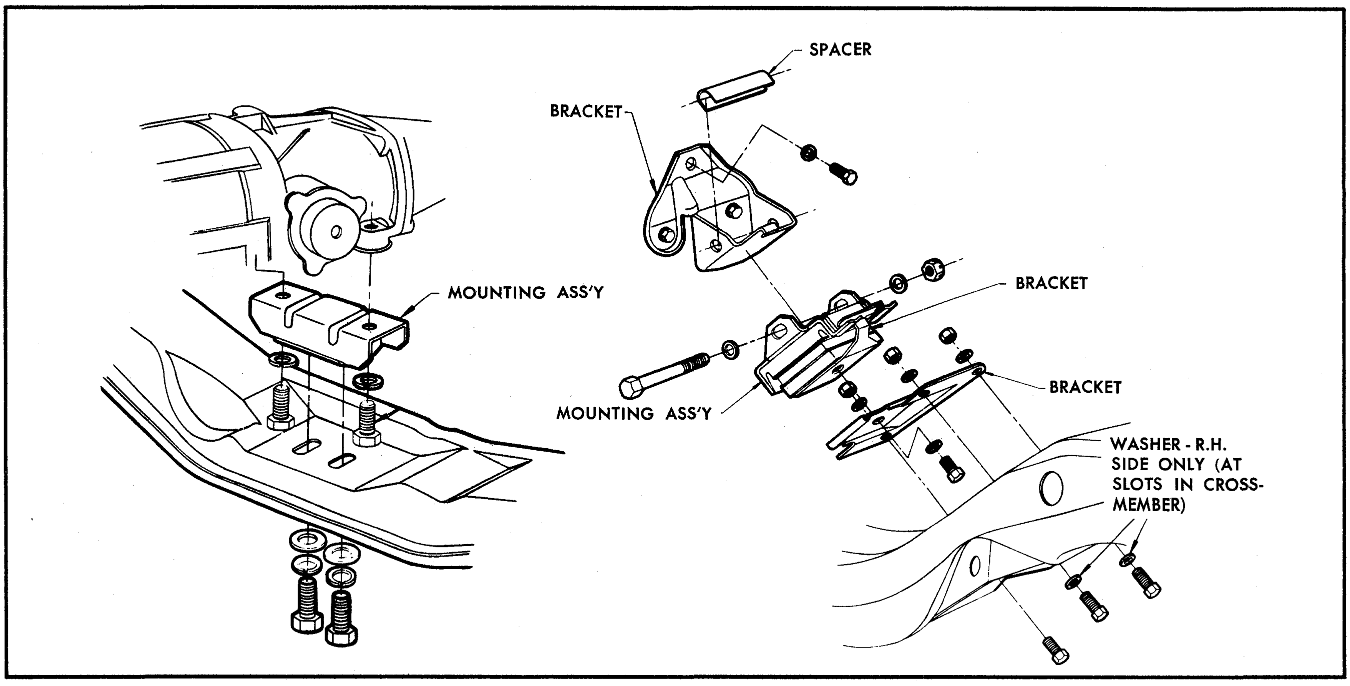



Fig. 6-14 Engine Insulators

connected with the engine consist of tune-up, lubrication, replacing oil filter, fuel filter, etc. Procedures and recommendations for these services will be found in appropriate sections of this book.

## SERVICE OPERATIONS ON CAR

### *ENGINE INSULATORS— REMOVE AND REPLACE (Fig. 6-14)*

FRONT INSULATORS

1. Remove cross member to rear insulator bolts.

2. Support engine with suitable lifting equipment.

3. Remove insulator to engine bracket through bolts.

4. Raise engine approximately 1" above front insulators.

5. Remove front insulator by unscrewing frame bracket to insulator bolt and lifting insulator from bolt.

6. Install new insulator.

7. Drop front of engine into position and install insulator to engine bracket bolts. Tighten nuts to 25-35 lb. ft.

8. Raise engine at rear to allow rear insulator to reposition.

9. Lower engine and transmission assembly so that rear insulator rests on cross member.

10. Install cross member to insulator bolts and tighten to 25-35 lb. ft.

REAR INSULATOR

1. Remove cross member to rear insulator bolts.

2. Raise rear of engine and transmission with suitable lifting equipment.

3. Remove insulator to transmission housing bolts.

4. Replace insulator and install insulator to transmission housing bolts. Tighten to 25-35 lb. ft.

5. Lower engine and transmission into position.

6. Install cross member to insulator bolts and tighten to 25-35 lb. ft.

### *DRIVE BELTS—ADJUST*

Engine fan and accessory drive belts may be adjusted by use of the Burroughs Belt Tension gauge. Section 6-A gives the correct specifications for both methods.

### *ENGINE—REMOVE AND INSTALL*

REMOVE

1. Scribe alignment marks on hood around hood hinges and remove hood from hinges.

2. Raise vehicle on hoist.

3. Drain cooling system and crankcase.

4. Disconnect radiator hoses and heater hoses at engine attachment.

5. Disconnect battery cables at battery.

6. Remove radiator.

7. Remove air cleaner.

8. Disconnect coil, starter and generator wires, engine-to-body ground strap, oil pressure and engine temperature sender wires.

9. Disconnect gas tank line at fuel pump.

10. Disconnect accelerator control linkage at fire wall.

11. Disconnect exhaust pipe from manifold.

12. Disconnect clutch cross shaft bracket at frame and disconnect clutch push rod, spring and pedal linkage. On models with automatic transmission, remove transmission oil filler tube and plug opening.

13. Remove drive shaft by removing rear universal joint U-bolts. Plug the end of the transmission extension housing.

14. Remove two lower transmission mounting bolts.

15. Disconnect speedometer cable and transmission control rod linkage lower ends.

16. Loosen engine front mounting bolts.

17. Raise engine slightly and remove front engine mounting bolts, nuts and washers.

18. Free the transmission rear mounting from cross member.

19. Remove the engine and transmission as a unit from the vehicle using suitable lifting equipment.

INSTALL

1. Install engine lifting equipment to engine and lower engine and transmission into chassis as a unit guiding engine to align front engine mounts with frame bracket.

2. Align and install rear mount bolts.

3. Install engine front mount bolts and remove lifting tool from engine.

4. Install drive shaft and U-bolts at rear U-joint.

5. Make the connections necessary for the type of transmission.

ON MANUAL TRANSMISSION MODELS:

a. Install clutch cross shaft on ball socket at block and bolt bracket to frame rail. Connect pedal and clutch fork push rods. Install return spring from clutch fork to left engine mount.

b. Connect transmission control rods to shifter levers on transmission side cover. Adjust control rods as outlined in TRANSMISSION SECTION.

ON AUTOMATIC TRANSMISSION MODELS:

a. Connect transmission control rod and throttle valve rod at transmission and adjust as outlined in TRANSMISSION SECTION.

b. Install transmission filler tube and dipstick.

6. Connect carburetor linkage.

7. Connect speedometer cable to driven gear at transmission.

8. Check transmission lubricant lever. Fill if necessary.

9. Carefully connect exhaust pipe to manifold and tighten securely.

10. Connect wire harness to temperature sending unit, oil pressure sending unit and coil primary terminal. Attach armature and field wires to generator.

11. Attach fuel line to fuel pump.

12. Attach wires and battery cable to starter solenoid.

13. Install radiator assembly.

14. Refill radiator and crankcase.

15. Install hood assembly, aligning previously scribed marks.

### *INTAKE AND EXHAUST MANIFOLDS OR GASKETS—REMOVE AND REPLACE*

REMOVE

1. Remove air cleaner wing nut and air cleaner.

2. Disconnect both throttle rods at bell crank and remove throttle return spring.

3. Disconnect fuel and vacuum lines from carburetor. Disconnect thermostatic coil rod at carburetor.

4. Remove carburetor for manifold replacement.

5. Disconnect exhaust pipe at manifold flange.

6. Remove manifold to head attaching bolts and clamps and remove manifolds as an assembly.

REPLACE

1. Clean gasket flanges on cylinder head and manifolds.

2. Check for cracks on manifold castings.

3. If necessary to replace either intake or exhaust manifold, separate them by removing 1 attaching bolt

and 2 nuts at center of assembly. Reassemble manifolds using new gasket. Tighten finger tight and torque 15-30 lb. ft. after assembly to cylinder head.

4. Position new gaskets over manifold end studs on head and carefully install the manifold in position making sure the gaskets are in place.

5. Install bolts and clamp while holding manifold in place with one hand.

6. Tighten center clamp bolts to 25-30 lb. ft. and end bolts to 15-20 lb. ft. (Fig. 6-15).

7. Connect exhaust pipe to manifold using a new packing seal.

8. Reverse Steps 1-4 of Removal to complete installation procedure.

### PUSH ROD COVER OR GASKET—REMOVE AND REPLACE

REMOVE

1. Loosen coil to block attaching screw and rotate coil upwards for clearance.

2. Remove push rod cover screws and remove cover.

REPLACE

1. Place new gasket in push rod cover.

2. Install cover to block.

3. Return coil to original position and tighten attaching screw.

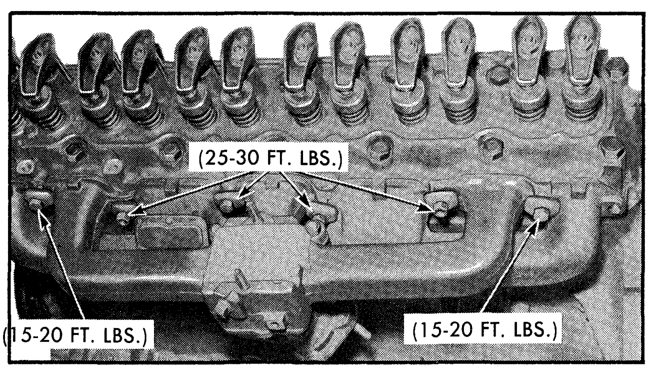



Fig. 6-15 Manifold Attaching Points

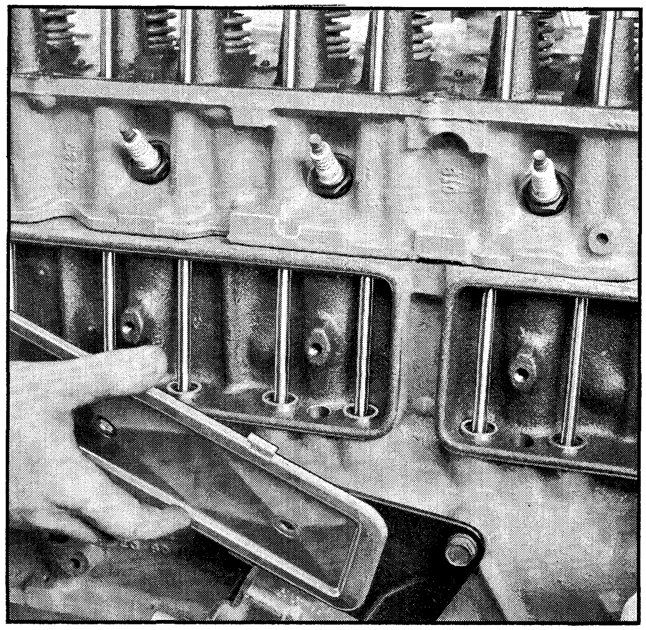


Fig. 6-16 Removing Push Rod Covers

### VALVE SPRINGS, SHIELDS OR SEALS—REMOVE AND REPLACE

REMOVE

1. Remove rocker arm cover.

2. Remove rocker arm.

3. Remove spark plug from cylinder of valves to be serviced.

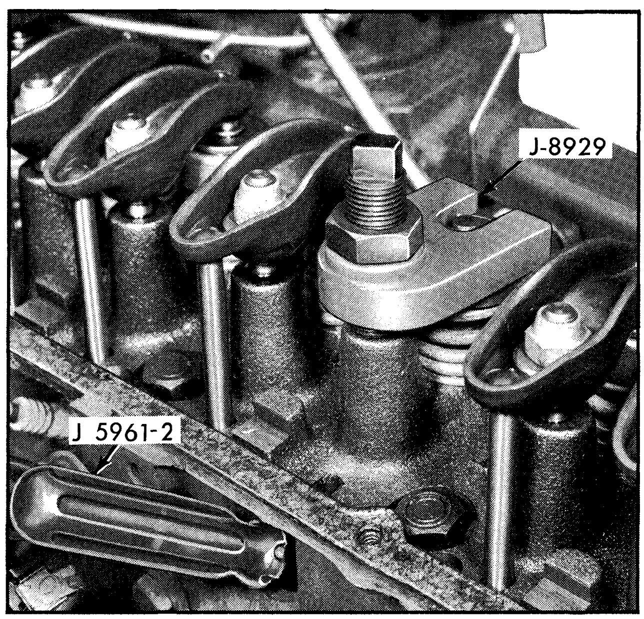



Fig. 6-17 Valve Spring Compressor Installed

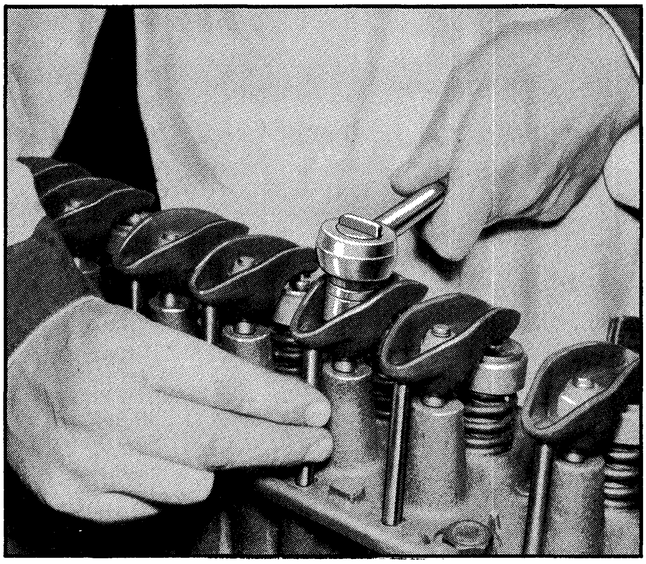


Fig. 6-18 Adjusting Valve Lifter Plunger Travel

4. After removing rocker arm, thread valve spring compressor stud J-8929-1 on rocker arm stud. Compress valve spring using compressor J-8927-4 and nut J-8929-2 while holding valve up with valve holder J-5961-2 (Fig. 6-17). Remove valve spring retainer cup locks and then remove valve spring compressor, valve spring retainer cup shield and valve stem seal.

5. Remove valve springs.

REPLACE

1. Install any new parts by reversing removal procedures 2-5.

*NOTE: Install spark plug after removing valve train play.*

2. With lifter on base circle of camshaft, turn rocker arm down until valve train play is removed. Turn nut down one additional turn (Fig. 6-18).

3. Install rocker arm cover.

### *PUSH ROD OR VALVE LIFTER— REMOVE AND REPLACE*

REMOVE

1. Remove rocker arm cover.

2. Loosen rocker arm and rotate it for clearance from push rod.

3. Remove push rod (Fig. 6-19) and store so that each push rod may be installed in original location.

If hydraulic valve lifters are to be removed, proceed as follows:

4. Remove spark plug from cylinder of valve train being serviced.

5. Disconnect distributor primary lead.

6. Loosen coil mounting screw and rotate coil upwards.

7. Remove push rod covers.

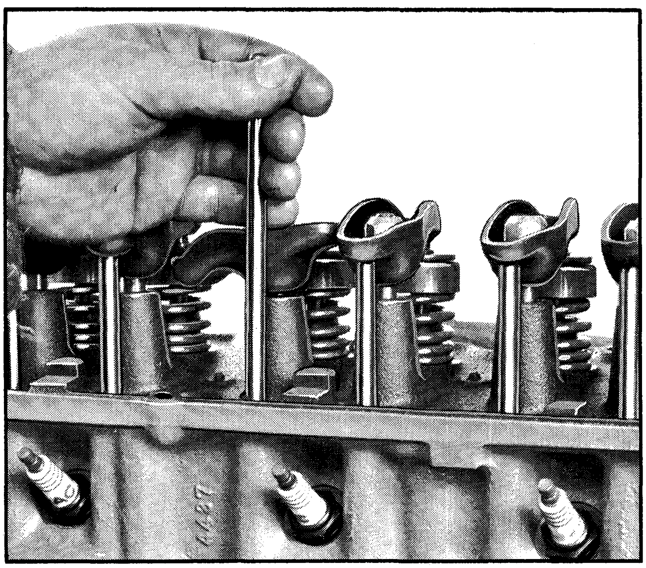


Fig. 6-19 Removing Push Rod


Fig. 6-20 Valve Lifter Storage Box

8. Remove lifter. Hydraulic valve lifter remover J-3049 may facilitate removal of lifter. Store lifters so that they can be installed in exactly the same location.

*NOTE: If new lifter is to be installed be sure to remove all sealer coating from inside of new lifter and check leak down rate.*

1. Place lifter in original lifter boss.

2. Replace push rod exactly as removed.

3. Position rocker arm or push rod.

4. With lifter on base circle of camshaft, tighten rocker arm nut until valve train play is removed. Turn nut down one additional turn (Fig. 6-18).

5. Install spark plug.

6. Install rocker arm cover.

### *HYDRAULIC VALVE LIFTERS—RECONDITION*

*NOTE: Because of the important part hydraulic valve lifters play in the operation of an engine and the close tolerances to which they are manufactured, proper handling, and above all, cleanliness, cannot be overstressed when servicing these parts.*

New lifters are serviced as individual units packaged with a plastic coating. Leave the coating on until ready to check leak down rate. It is not necessary to remove the oil from new lifters prior to checking leak down rate since special leak down oil is already in new lifters.

Wash tank and tray J-5821 is recommended for cleaning valve lifters. This tank should be used only for valve lifters and should be kept covered when not in use. All servicing should be done in an area removed from grinders or other sources of dust and foreign material.

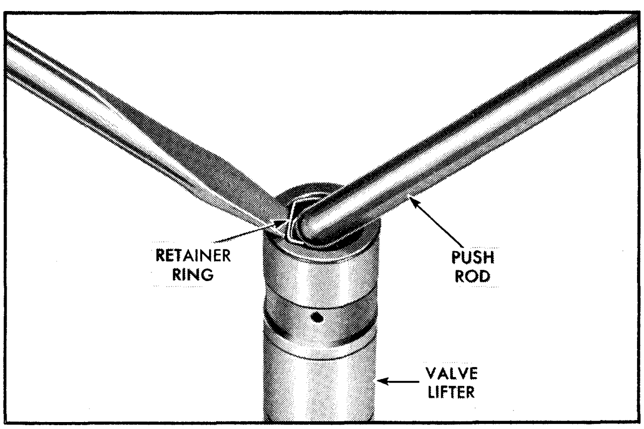



Fig. 6-21 Removing Push Rod Seat Retaining Ring

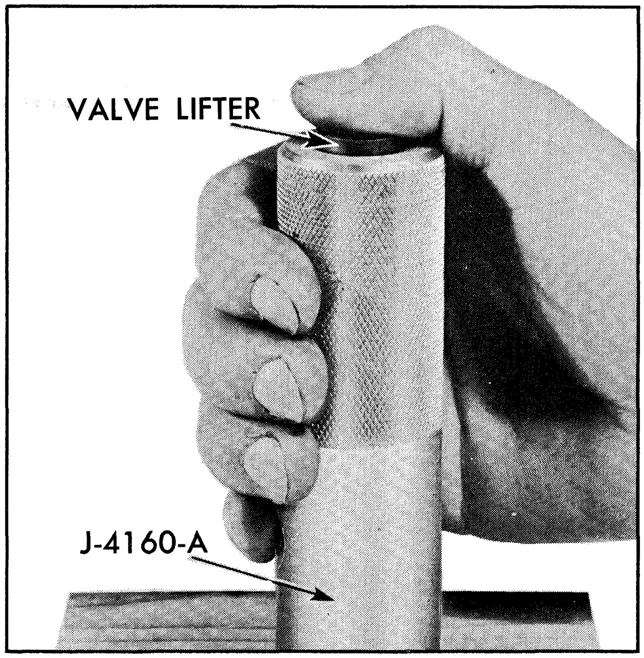



Fig. 6-22 Removing Stuck Plunger

Lifters should at all times be stored in a covered box (Fig. 6-20) which will aid in keeping them clean. The lifter box should be kept dry and as free of oil as possible.

### VALVE LIFTER—DISASSEMBLE

1. Remove push rod seat retainer ring by holding seat down with push rod while dislodging spring from lifter body with a pointed tool (Fig. 6-21). NOTE: It may be necessary to unseat lifter ball, using plunger unloader J-5097, before plunger can be pushed down.

2. Invert lifter and allow push rod seat and plunger to slide out of body. If plunger sticks in body, place lifter in large end of hydraulic valve lifter plunger remover, J-4160-A, with push rod end of lifter downward. Hold tool firmly in hand with thumb over lifter body and sharply strike tool against a block of wood (Fig. 6-22) until plunger falls out.

*NOTE: It may be necessary to soak a lifter having a stuck plunger in cleaning solvent for several minutes in order to remove the plunger.*

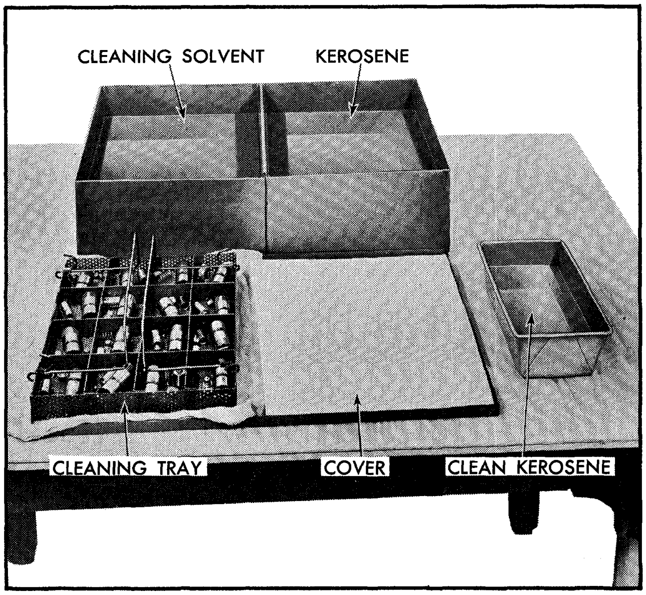



Fig. 6-23 Lifter Wash Tank and Tray

3. Drain oil out of lifter body and place all valve lifter parts in separate compartment of tray from wash tank J-5821 (Fig. 6-23).

*CAUTION: Valve lifter body and plunger are selectively fitted and must not be interchanged with parts of other lifters. (Keeping all parts of lifters together will also aid in trouble diagnosis.)*

VALVE LIFTER—CLEAN AND INSPECT

Wash tank J-5821 is recommended for cleaning valve lifter parts. This tank consists of two chambers, a tray and a cover. One chamber is for cleaning solvent and the other is for kerosene. Whenever the tank is not being used (and when parts are soaking), the cover should be closed.

1. Before placing tray of parts in cleaning solvent, first immerse it in kerosene chamber to remove as much engine oil as possible. (This reduces contamination of solvent, thus prolonging its useful life.)

2. Submerge tray in cleaning solvent and allow to soak for approximately one hour. More time may be required depending on varnish condition and effectiveness of solvent. Light agitation of tray in solvent at 10-15 minute intervals will hasten cleaning action.

3. After varnish has dissolved or has been sufficiently softened to permit removal by wiping, suspend tray above solvent, utilizing hooks on tray handles. Allow tray and parts to drain for a brief period.

4. Rinse tray of parts in kerosene chamber to cut solvent and to avoid injury to hands (from solvent).

5. Wipe out tank cover and place tray of parts on cover in front of tank. A shop towel under tray and clean paper on remainder of cover will ensure cleanliness.

6. Working on one lifter at a time and using clean, lint-free cloths, thoroughly wipe off lifter parts. Clean plunger and external and internal surfaces of body with a hard wiping action. A bristle brush may be used to clean internal surface of lifter body.

*CAUTION: Do not use wire brush or sand paper, as these may damage machined surfaces.*

*NOTE: Absolute cleanliness can be assured if each lifter is inspected and assembled after cleaning, but before proceeding to the next lifter.*

7. Inspect lifter body. Both inner and outer surfaces of lifter body should be inspected for scoring. Lifter assembly should be replaced if body is roughly scored, grooved, or galled. Inspect cam contact surface on lower end of lifter body. Replace lifter assembly if this surface is excessively worn, galled or otherwise damaged.

8. Inspect lifter plunger. Using a magnifying glass, inspect the check ball seat for defects. Inspect outer surface of plunger for scratches or scores. Small score marks with a rough, satiny finish will cause the plunger to seize when hot but operate normally when cool. Defects in check ball seat or scores or scratches on outer surface of plunger which may be felt with a fingernail are causes for replacing the lifter assembly. This rule does not apply to the slight edge which may sometimes be present where the lower end of plunger extends below the ground inner surface of the body. This edge is not detrimental unless it is sharp or burred.

A blackened appearance is not a defective condition. Sometimes the discoloration serves to highlight slight grinder chatter marks and give the outer surface of plunger a ridged or fluted appearance. This

condition will not cause improper operation, therefore, it may be disregarded.

9. Inspect push rod seat for roughness and to insure that hole in center is open.

10. Inspect valve lifter ball. Carefully examine ball for nicks, embedded material or other defects which would prevent proper seating. Such defects may cause intermittently noisy lifter operation. Also inspect plunger face of ball retainer for excessive wear.

## VALVE LIFTER—ASSEMBLE

*NOTE: All parts must be absolutely clean when assembling a hydraulic lifter. Since lint and dust may adhere to parts they should not be blown off with air or wiped with cloths. All parts should be rinsed in clean kerosene and assembled without drying. A small container with clean kerosene (separate from cleaning tank) should be used for each set of lifters being overhauled.*

Figure 6-24 shows the relative position of component parts of valve lifters. The recommended procedure for assembly is given in the following steps.

1. Rinse plunger spring and ball retainer and position retainer in spring.

2. Rinse lifter ball and place in retainer.

3. Rinse plunger and place on retainer so that seat on plunger mates with ball.

4. Invert plunger with parts assembled thus far and after rinsing lifter body, install body over spring and plunger.

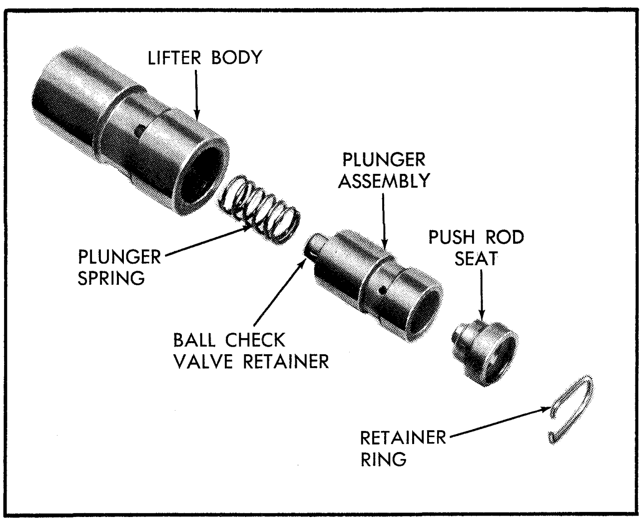



Fig. 6-24 Exploded View - Valve Lifter

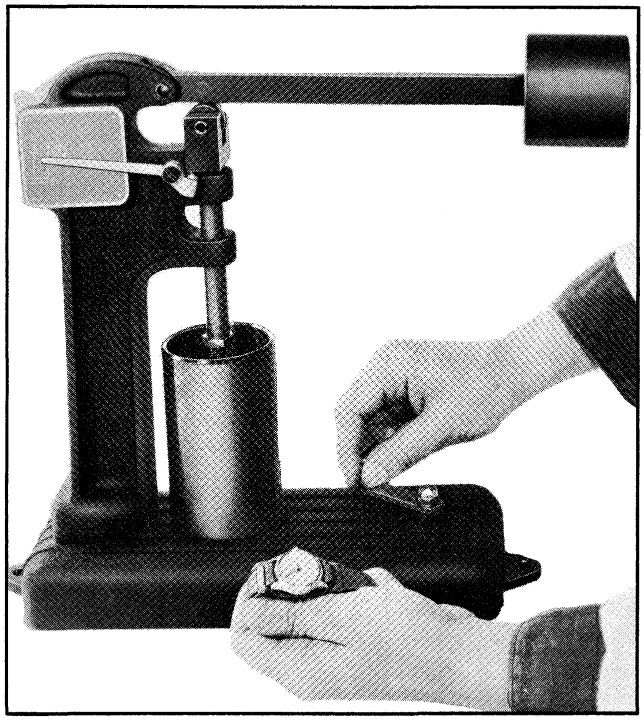


Fig. 6-25 Testing Leak Down Rate

5. Place lifter body on clean paper, rinse and install push rod seat and retainer ring.

6. After lifter has been assembled, place in lifter box and close lid to preserve cleanliness.

## VALVE LIFTER TEST LEAK DOWN RATE

After all lifters have been assembled, the leak down rate must be checked before they are installed in the engine. Valve lifter lead down tester J-5790 (Fig. 6-25) is designed to test leak down rate of lifters to determine whether or not they are within specified limits. As with previous service operations concerned with lifters, cleanliness is paramount. The tester cup, and ram should be thoroughly cleaned, and testing should be done in an area free of dust and dirt. The testing procedure is described in the following steps:

1. Fill tester cup to approximately one inch from top with special fluid which is available from tester manufacturer.

2. Swing weight arm up out of the way, raise ram, and position lifter into boss in center of tester cup.

3. Adjust ram (with weight arm clear of ram) so that the pointer is positioned on the set line (marked "S"). Tighten jam nut to maintain setting.

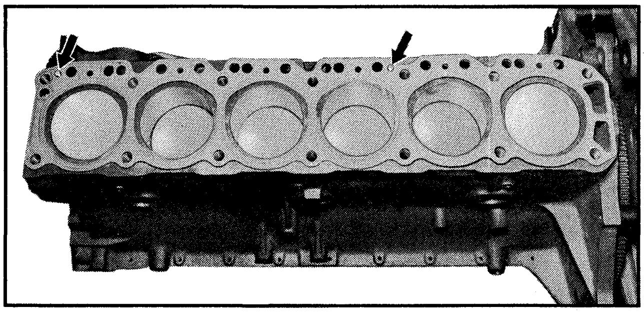


Fig. 6-26 Installing Head Gasket

4. Operate lifter through full travel of plunger by pumping weight arm to fill lifter with test fluid and force out air. (Lifter must be completely submerged at all times.) Continue pumping for several strokes after definite resistance is detected.

5. Raise weight arm to allow plunger spring to expand fully; lower arm onto ram and commence turning crank slowly (1 revolution every 2 seconds).

Time indicator travel from lower line (first line above set line) to line marked .094 or 3/32", while still rotating cup with crank (Fig. 6-25). Lifter is satisfactory if rate is between 12 and 65 seconds.

### *CYLINDER HEAD OR GASKET— REMOVE AND REPLACE*

REMOVE

1. Drain cooling system and remove air cleaner.

2. Disconnect accelerator pedal rod at bell crank on manifold and fuel and vacuum lines at carburetor.

3. Disconnect exhaust pipe at manifold flange, then remove manifold bolts and clamps and remove manifolds and carburetor as an assembly.

4. Remove fuel and vacuum line retaining clip from water outlet and disconnect wire harness from temperature sending unit and coil leaving harness clear of clips on rocker arm cover.

5. Disconnect radiator hose at water outlet housing and battery ground strap at cylinder head.

6. Disconnect wires and remove spark plugs. Disconnect coil to distributor primary wire lead at coil and remove coil.

7. Remove rocker arm cover. Back off rocker arm nuts, pivot rocker arms to clear push rods and remove push rods.

8. Remove the cylinder head bolts, cylinder head and gasket. Place cylinder head on two blocks of wood to prevent damage.

REPLACE

1. Place a new cylinder head gasket in position over dowel pins in cylinder block (Fig. 6-26).

2. Carefully guide cylinder head into place over dowel pins and gasket (Fig. 6-27).

3. Coat threads of cylinder head bolts with sealing compound, install and run them down to the block.

4. Tighten the cylinder head a little at a time with a torque wrench. Tighten center bolts and then end bolts. The final torque should be 90 to 95 ft. lbs.

5. Install valve push rods down through openings in the cylinder head and seat them in lifter sockets.

6. Install rocker arms, balls and nuts and tighten rocker arm nuts until all push rod play is taken up (Fig. 6-18).

7. Install thermostat housing thermostat and water outlet using new gaskets and connect radiator hose.

8. Install temperature sending switch and tighten to 15-20 ft. lbs.

9. Clean all spark plugs with abrasive-type cleaner, inspect for damage and set the gap at .035" using a wire gauge.

10. Install coil then connect temperature sending unit and coil primary wires, and connect battery ground cable at cylinder head.

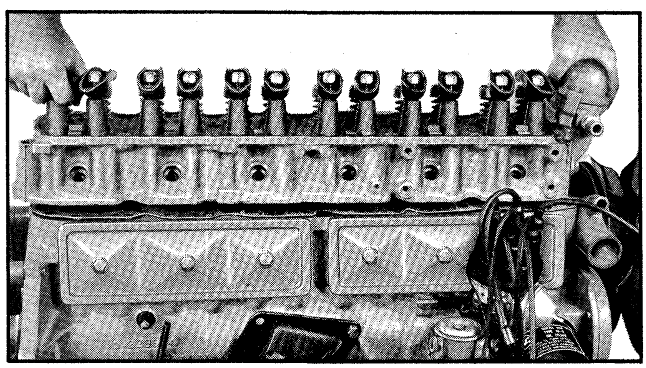


Fig. 6-27 Installing Cylinder Head

11. Clean manifold gasket surfaces and install new gasket over manifold studs. Position manifold and slide it into place over the studs, making sure it seats against the gasket. Install bolts and clamps and tighten as shown in Fig. 6-28.

12. Connect throttle linkage and adjust as shown in Section 6B.

13. Connect fuel and vacuum lines to carburetor and install lines in clip at water outlet.

14. Fill cooling system and check for leaks.

15. With lifter on base circle of camshaft, tighten rocker arm nut until valve train play is removed. Tighten nuts one more turn.

16. Install spark plugs and tighten to 20-25 lbs. ft.

17. Install rocker arm cover and position wiring harness in clips on cover.

18. Clean and install air cleaner.

## *ROCKER ARM STUDS—REMOVE AND REPLACE*

Rocker arm studs that have damaged threads may be replaced with standard studs. If the studs are loose in the head oversize studs, available in .003" oversize, may be installed after reaming the holes with tool J-5715 for .003" oversize.

REMOVE

1. Remove cylinder head.

2. Remove rocker arm.

3. File two slots 3/32" to 1/8" deep on opposite sides or rocker arm stud (Fig. 6-29). Bottom of slots should be 1/2" from top of studhole (Fig. 6-29).

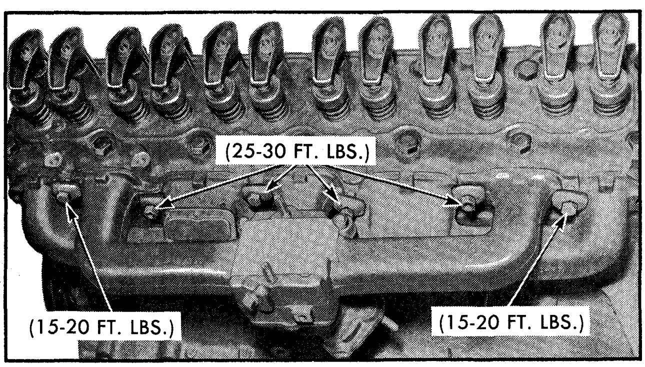



Fig. 6-28 Manifold Attaching Points

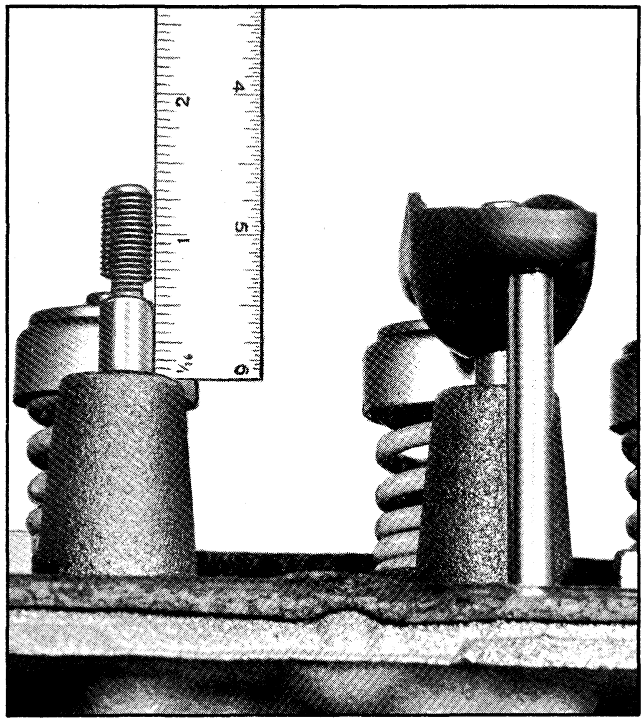


Fig. 6-29 Slots for Removing Rocker Arm Stud

4. Place washer J-6392-3 at bottom of rocker arm stud (Fig. 6-30).

5. Position rocker arm stud remover J-6392-1 on stud and tighten screws securely with 5/32" allen wrench.

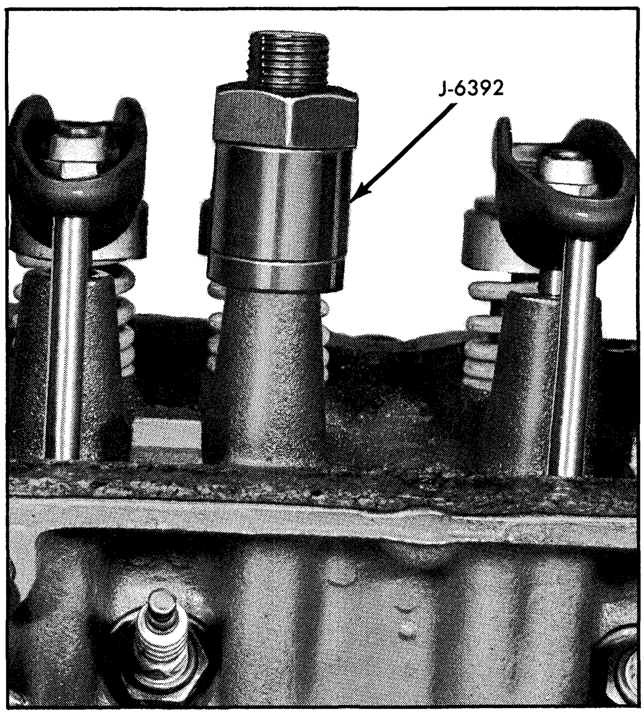



Fig. 6-30 Tool Installation for Removing Rocker Arm Stud

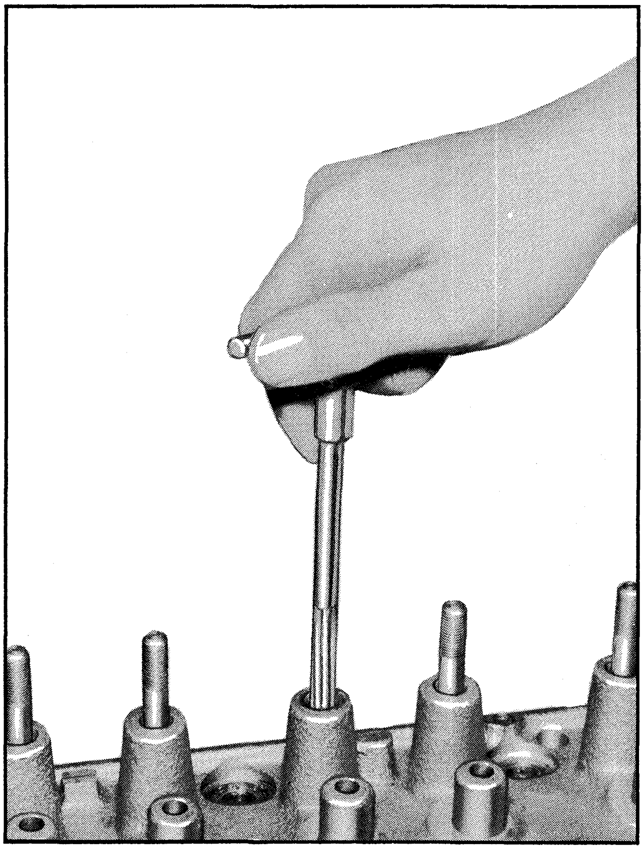


Fig. 6-31 Reaming Rocker Arm Stud Hole

6. Place spacer J-6392-2 over stud remover J-6392-1 (Fig. 6-30).

7. Thread 7/8" standard nut on stud remover and turn nut until stud is out of cylinder head (Fig. 6-30).

8. Ream rocker arm stud hole if oversize stud is to be used (Fig. 6-31).

REPLACE

1. Coat press-fit area of stud with hypoid axle lubricant.

2. Install new stud using tool J-6880. Tool should bottom on head (Fig. 6-32).

3. Install cylinder head.

4. Install push rod and rocker arm.

5. Remove spark plug from cylinder of valve train being serviced.

6. With lifter on base circle of camshaft tighten rocker arm nut until all valve train play is removed. Tighten nut one additional turn.

7. Install spark plug.

8. Install rocker arm cover.

## CYLINDER HEAD AND VALVES—RECONDITION

The condition of the cylinder head and valve mechanism, significantly determines the power, performance and economy of a valve-in-head engine. Extreme care should be exercised when conditioning the cylinder head and valves to maintain correct valve stem to guide clearance, correctly ground valves, valve seats of correct width and correct valve adjustment.

DISASSEMBLE

1. Remove the cylinder head and gasket as previously described. Place cylinder head on two blocks of wood to prevent damage.

2. Remove rocker arm nuts, ball seats and rocker arms.

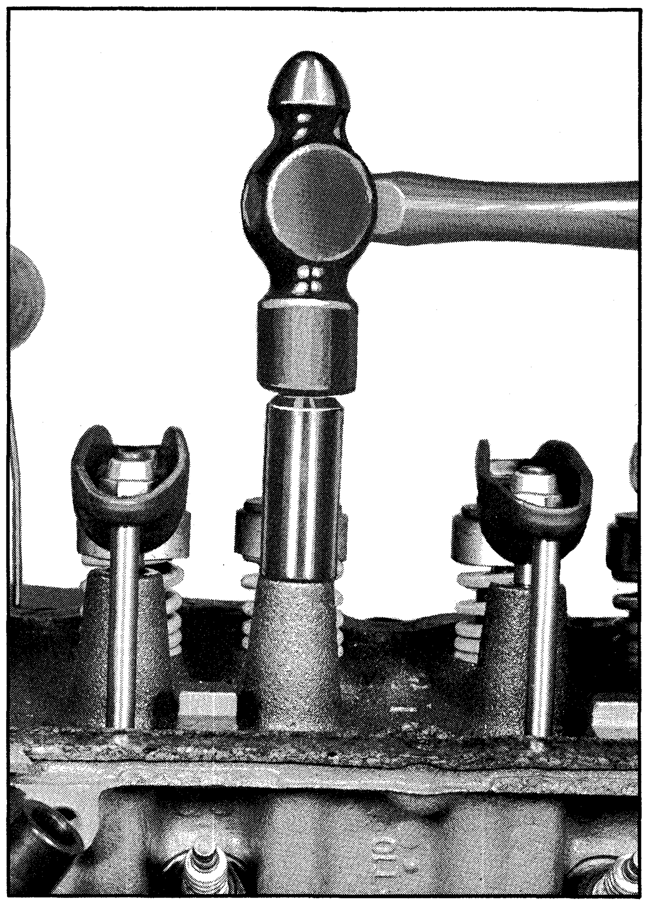


Fig. 6-32 Installing New Rocker Arm Stud

3. Using tool J-8929, compress the valve springs and remove valve keys. Remove spring caps, spring seats, oil seals, springs and spring dampers (Fig. 6-33).

4. Remove valves from bottom of cylinder head and place them in a rack in their proper sequence so they can be assembled in their original positions.

5. Remove water outlet and thermostat, then remove thermostat housing.

CLEAN AND INSPECT

1. Clean all carbon from combustion chambers and valve ports.

2. Thoroughly clean the valve guides using tool J-8101 (Fig. 6-34).

3. Clean all carbon and sludge from push rods and rocker arms.

4. Clean valve stems and heads on a buffing wheel.

5. Clean carbon deposits from head gasket mating surfaces.

6. Wash all parts in cleaning solvent and dry them thoroughly.

7. Inspect the cylinder head for cracks in the exhaust ports, combustion chambers, or external cracks to the water chamber.

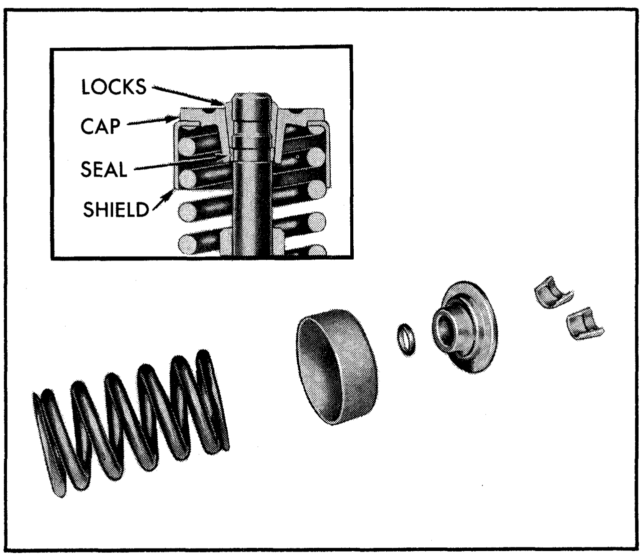



Fig. 6-33 Upper Valve Train Parts

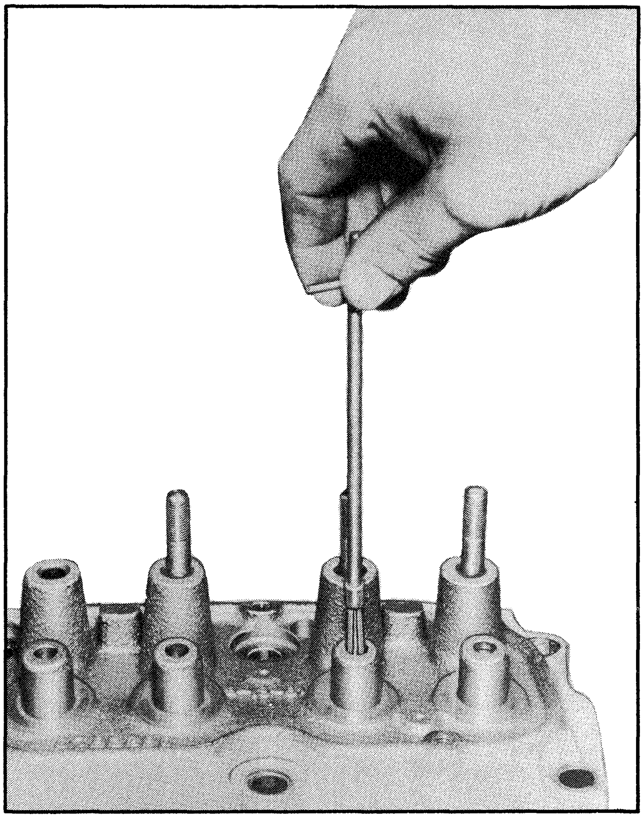


Fig. 6-34 Cleaning Valve Guide Bore

8. Inspect the valves for burned heads, cracked faces or damaged stems.

9. Check fit of valve stems in their respective bores.

*NOTE: Excessive valve stem to bore clearance will cause lack of power, rough idling and noisy valves, and may cause valve breakage. Insufficient clearance will result in noisy and sticky functioning of the valve and disturb engine smoothness of operation. Intake valve stem to bore clearance should be .001" to .003" while exhaust stem clearance should be .002" to .004". By using a micrometer and a suitable telescope hole gauge, check the diameter of the valve stem in three places; top, center and bottom. Insert telescope hole gauge in valve guide bore, measuring at the center. Subtract highest reading of valve stem diameter from valve guide bore center diameter to obtain valve to valve guide clearance. If clearance is not within limits use next oversize valve and ream bore to fit using suitable reamer of tool J-7049 (Fig. 6-35).*

4. Check valve spring tension with suitable tester (Fig. 6-36).

*NOTE: Springs should be compressed to 1-21/32" at which height it should check 84-92 pounds. Weak springs affect power and economy and should be replaced if below 70 pounds.*

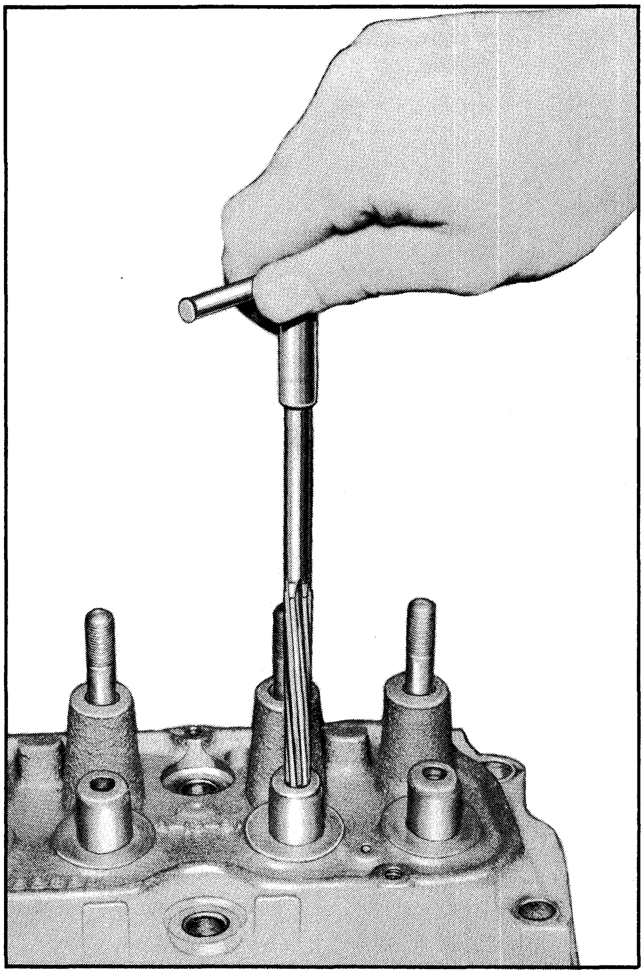


Fig. 6-35 Reaming Valve Guide Bore

5. Check valve lifters for free fit in block. The end that contacts the camshaft should be smooth. If this surface is worn or rough the lifter should be replaced.

VALVE GUIDE BORE - RECONDITION

Valves with .003" oversize stems are available for inlet and exhaust valves. Use the 3/8" diameter reamer sizes, which are: J-8814, Standard and J-5830-1, .003" Oversize.

***VALVES AND SEATS—RECONDITION***

1. Reface valves and seats as follows:

Valves should be ground on a special bench grinder designed specifically for this purpose and built by a reputable manufacturer. Valve seats should be ground with reputable power grinding equipment having stones of the correct seat angle and a suitable pilot which pilots in the valve stem guide. To ensure positive sealing of the valve face to its seat, the grinding stones should be carefully refaced before any grinding is done.

Intake and exhaust valve seat angle is 46°. Intake and exhaust valve face angle is 45°. This will provide hairline contact between valve and seat to provide positive sealing and reduce build-up of deposits on seating surfaces (Fig. 6-37).

*DO NOT USE REFACING EQUIPMENT EXCESSIVELY; only enough material should be removed to true up surfaces and remove pits. The valve head will run hotter as its thickness is diminished; therefore, if valve face cannot be cleaned up without grinding to point where outside diameter of valve has a sharp edge, the valve should be replaced. Whenever it is necessary to replace a valve, the new valve should be of the same stem diameter as the valve removed (unless the valve guide is reamed to provide proper fit).*

Width of exhaust valve seats should be 1/16" to 3/32". Intake valve seats should be 1/32" to 1/16" wide. If seat width is excessive, it should be narrowed by grinding with a flat stone. This is the only method that should be used to narrow the seat.

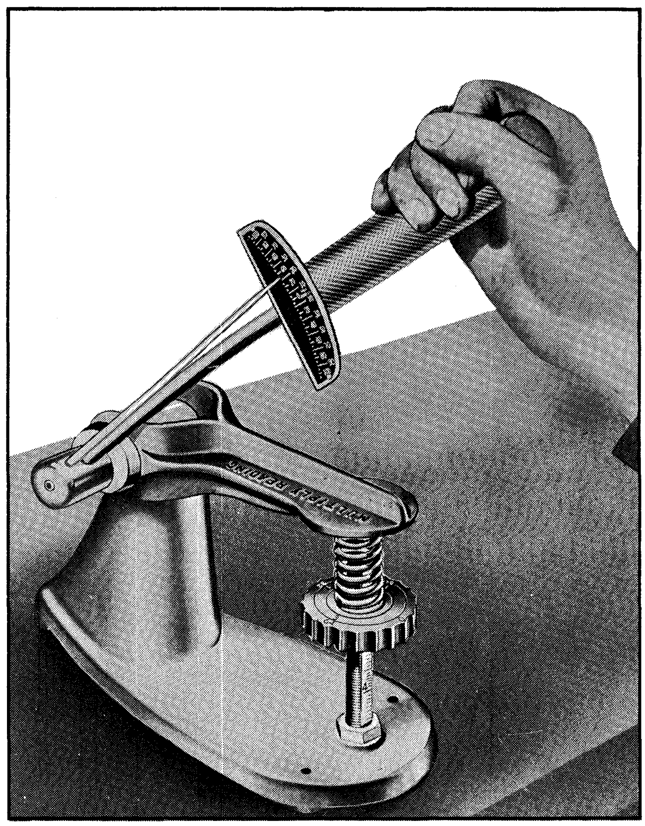


Fig. 6-36 Checking Valve Spring Tension

2. Check concentricity of valve seat and valve guide. Concentricity of valve seat and valve guide can be checked by using a suitable dial indicator or prussian blue. When using a dial indicator, total runout should not exceed .002".

When prussian blue is used, a light coat should be applied to the face of the valve only and the valve rotated in its seat. If blue appears all the way around the valve seat, the valve seat and the valve guide are concentric with one another.

3. Check concentricity of valve stem and face of valve. After cleaning prussian blue from valve and seat, lightly coat valve seat with prussian blue again and rotate valve in guide. If blue appears all the way around the valve, the valve stem and valve face are concentric with one another.

*NOTE: Both tests in steps 2 and 3 are necessary to insure proper valve seating.*

*IMPORTANT: If it is necessary to grind any pit from rocker arm end of valve stem, feed end squarely against grinding wheel. Only the extreme end of the valve stem is hardened to resist wear. Do not grind end excessively.*

ASSEMBLE

1. Starting with No. 1 cylinder, place the exhaust valve in the port and place the valve spring and cap in position. Place spring and rotator on exhaust valves. Then using suitable spring compressor, compress the spring and install the oil seal and valve keys. See that the seal is flat and not twisted in the valve stem groove and that the keys seat properly in the valve stem groove (Fig. 6-38).

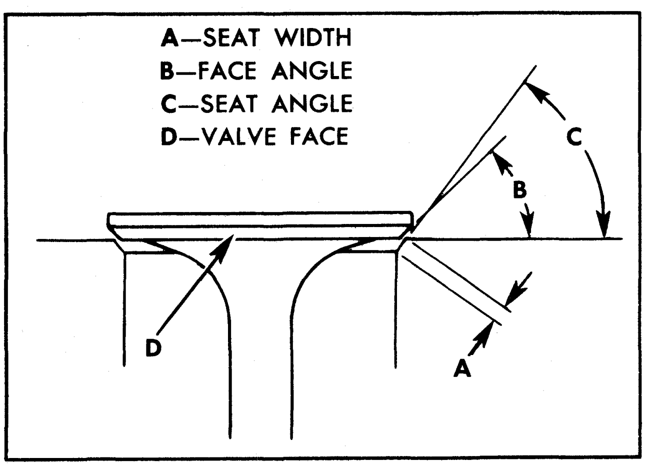



Fig. 6-37 Valve Seat and Face Angles

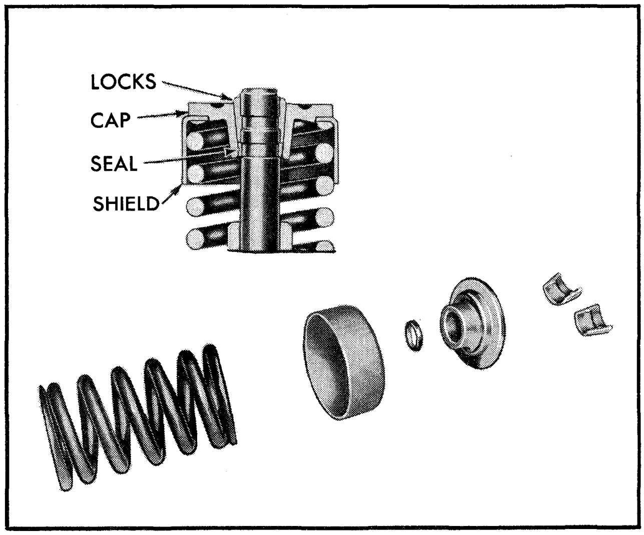



Fig. 6-38 Valve Installation

*NOTE: Place valve springs in position with the closed coil end toward the cylinder head.*

2. Assemble the remaining valves, valve springs, shields, spring caps, oil seals and valve locks in the cylinder head. Check seals by placing a vacuum cup over valve stem and cap, squeeze vacuum cup to make sure no oil leaks past oil seal.

3. Install cylinder head as previously described.

VALVE SPRING INSTALLED HEIGHT

Check the installed height of the valve springs, using a narrow, thin scale to measure from the top of the shim, or spring seat, in the head to the top of the valve spring shield. If this is found in excess of 1-23/32", install a valve spring seat shim, approximately 1/16" thick above the spring seating surface in the head. At no time should the spring be shimmed to give an installed height of less than 1-21/32" (Fig. 6-39).

## *HARMONIC BALANCER—REMOVE AND REPLACE*

REMOVE

1. Drain radiator and disconnect radiator hoses at radiator.

2. Remove fan and water pump pulley.

3. Remove radiator core and fan belt.


Fig. 6-39 Checking Valve Spring Installed Height

4. Install tool J-6978 to balancer and turn puller screw to remove balancer (Fig. 6-40). Then remove tool from balancer.

REPLACE

1. Coat front cover oil seal contact area of balancer with engine oil.

2. Attach balancer installer tool X-8792 (Fig. 6-41) to balancer (Fig. 6-42).

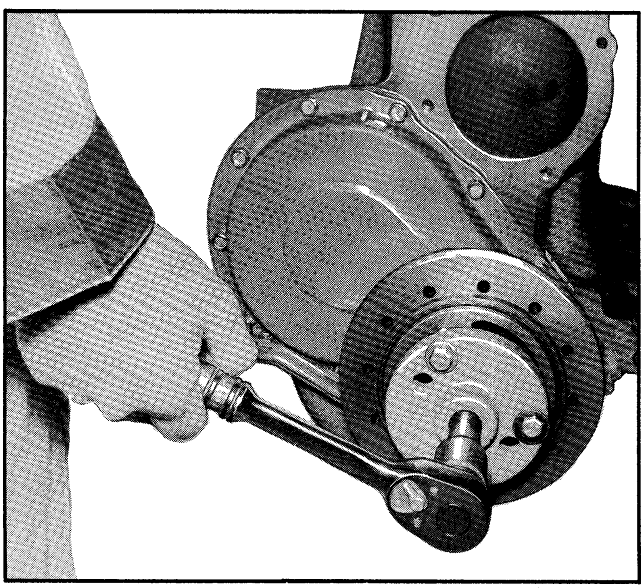


Fig. 6-40 Removing Harmonic Balancer

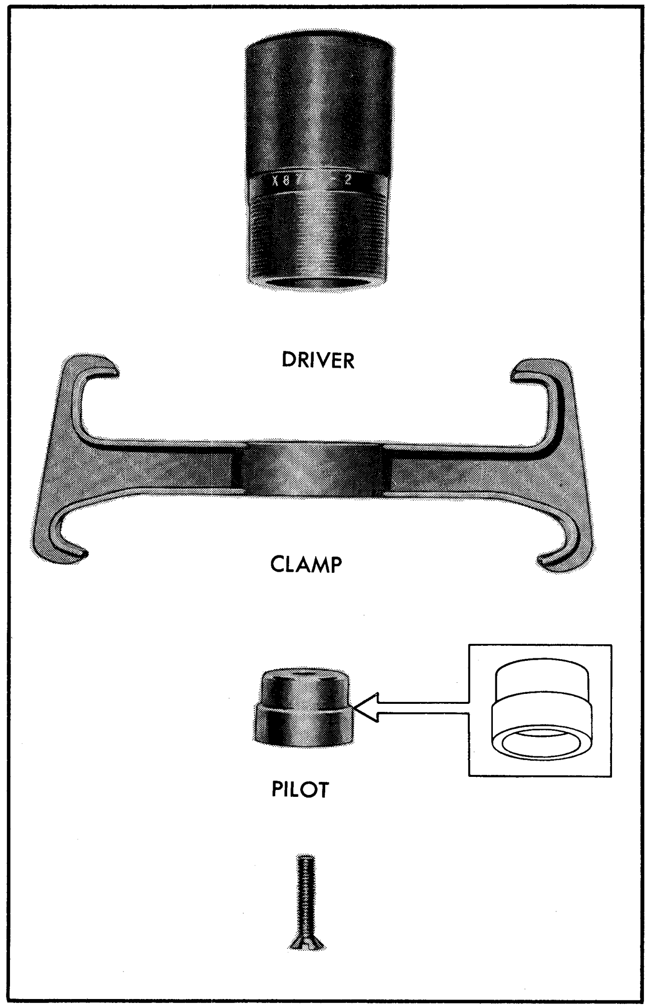



Fig. 6-41 Harmonic Balancer Installer

3. Position balancer on crankshaft and drive into position until it bottoms against crankshaft gear. Remove installer tool (Fig. 6-42).

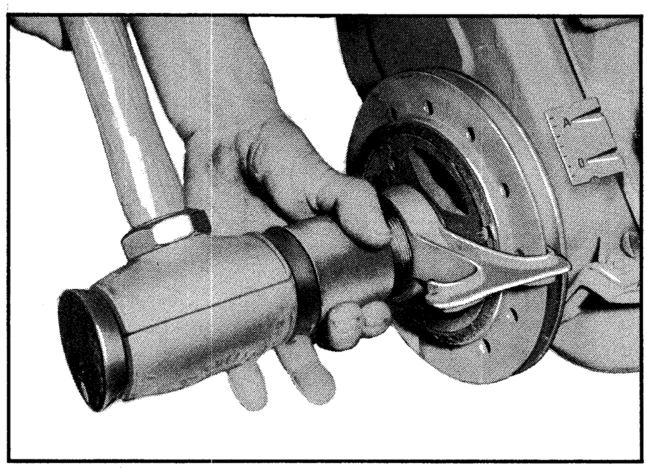


Fig. 6-42 Installing Harmonic Balancer

4. Install water pump pulley, fan and fan belt and adjust belt tension.

5. Install radiator core and connect radiator hoses.

6. Fill cooling system and check for leaks.

### *TIMING GEAR COVER—REMOVE AND REPLACE*

REMOVE

1. Remove harmonic balancer as previously described.

2. Loosen oil pan bolts and let oil pan rest against front cross member.

3. Remove timing gear cover attaching screws and remove cover and gasket.

OIL SEAL - REPLACE

(Seal can also be replaced with timing gear cover installed)

1. After removing harmonic balancer, pry seal out of timing gear cover with a large screwdriver.

2. Install new lip seal with lip toward inside of cover and drive it into position with tool J-5154 (Fig. 6-43).

OIL NOZZLE - REPLACE

1. Remove nozzle with pliers (Fig. 6-44).

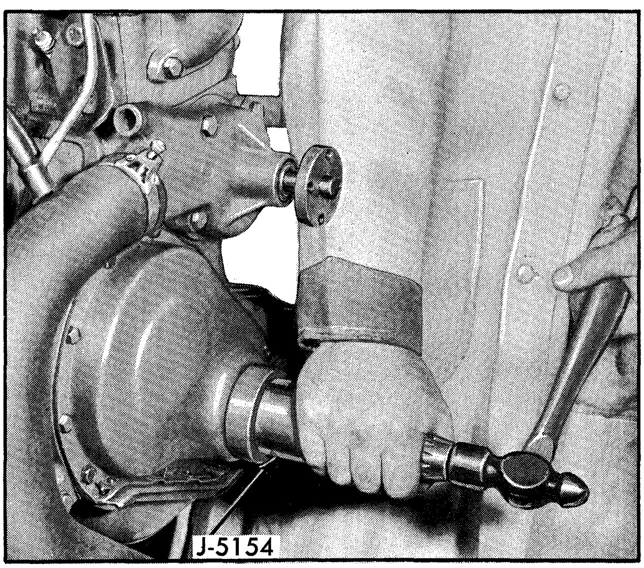



Fig. 6-43 Installing Timing Cover Oil Seal

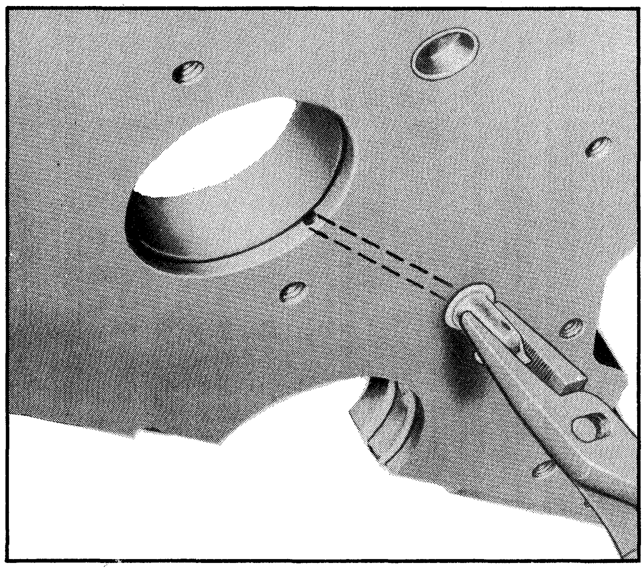


Fig. 6-44 Removing Timing Gear Oil Nozzle

2. Drive new nozzle in place using a suitable light plastic or rubber hammer.

REPLACE

1. Clean gasket surfaces on block and cover.

2. Install centering tool J-0966 over end of crankshaft.

3. Coat the gasket with light grease and stick a new cover gasket in position on block with light grease.

4. Install cover over centering tool (Fig. 6-45) and install cover screws. Torque screws to 6 to 8 ft. lbs. Remove centering tool.

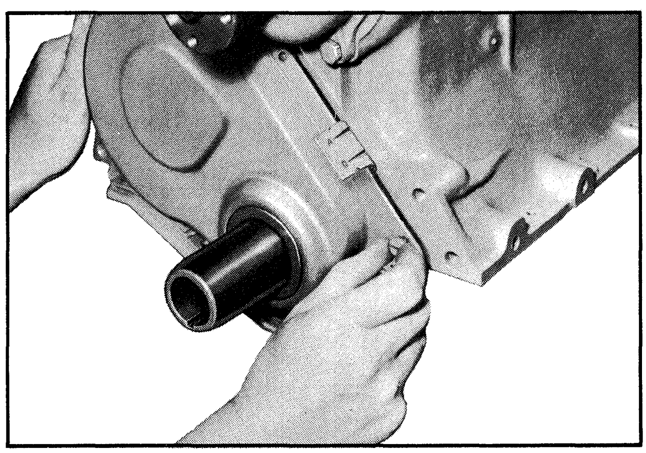


Fig. 6-45 Installing Timing Gear Cover

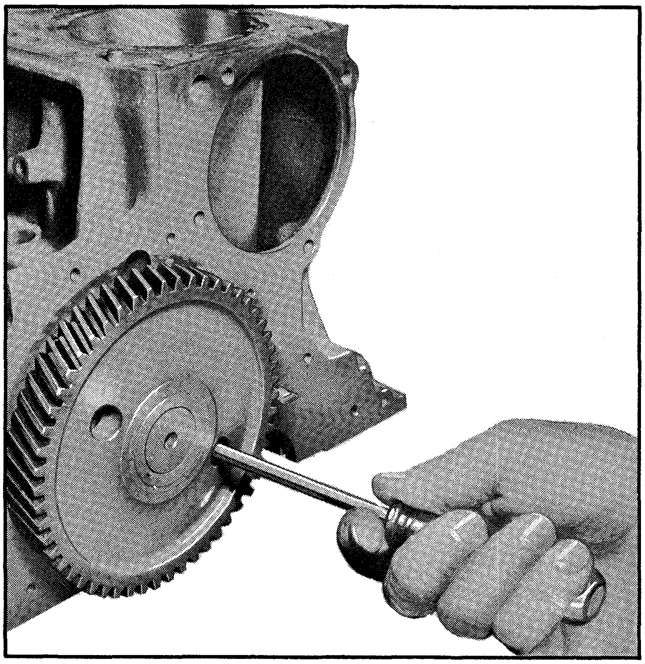


Fig. 6-46 Removing Camshaft Thrust Plate Screws

*NOTE: It is important that centering gauge be used to align cover so that harmonic balancer installation will not damage seal and to position seal to seal evenly around balancer hub surface.*

5. Move oil pan into position and tighten bolts.

6. Install harmonic balancer as previously described.

## CAMSHAFT—REMOVE AND REPLACE

REMOVE

1. Drain crankcase and radiator.

2. Remove radiator as described under "Engine Cooling," in Section 6-A.

3. Remove fan and water pump pulley.

4. Remove grille assembly. See Front End Sheet Metal, Section 10.

5. Remove valve cover and gasket, loosen valve rocker arm nuts and pivot rocker arms clear of push rods.

6. Remove distributor, fuel pump and spark plugs.

7. Remove coil, push rod covers and gasket. Remove push rod and valve lifters. Remove spark plugs.

8. Remove harmonic balancer using tool J-6978. Loosen oil pan bolts and allow oil pan to drop away from timing gear cover. Remove timing gear cover.

9. Remove the two camshaft thrust plate screws by working through holes in the camshaft gear (Fig. 6-46).

10. Remove the camshaft and gear assembly by pulling it out through the front of the block.

*NOTE: Support shaft carefully when removing so as not to damage camshaft bearings.*

DISASSEMBLE

1. If the gear must be removed from the shaft, use press plate J-6547 inside J-6407-2 on press.

2. Place tools on table of a press. Place the camshaft through the opening in the tools. Press shaft out of gear using socket or other suitable tool (Fig. 6-47).

*CAUTION: Thrust plate must be so positioned that woodruff key in shaft does not damage it when the shaft is pressed out of gear.*

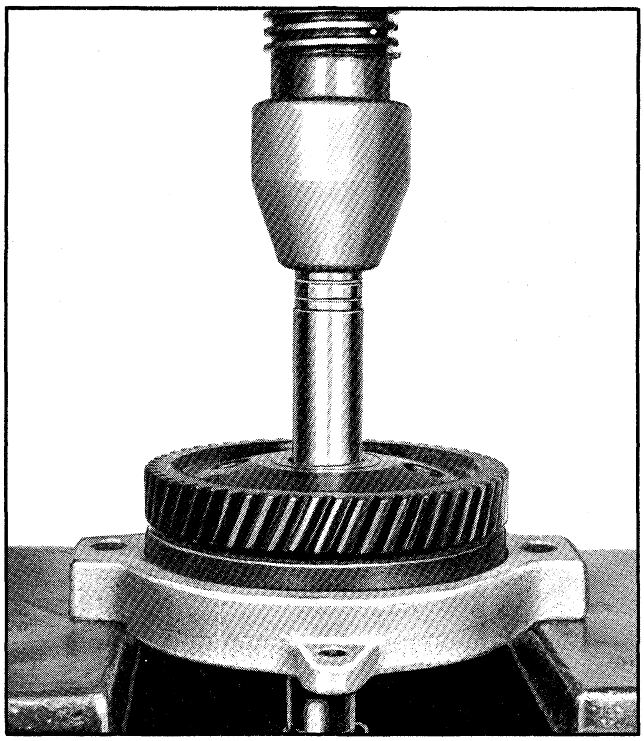


Fig. 6-47 Removing Camshaft Timing Gear

ASSEMBLE

To assemble camshaft gear, thrust plate and gear spacer ring to camshaft, proceed as follows:

1. Firmly support shaft at back of front journal in an arbor press using press plates J-9156 in J-6407-2.

2. Place gear spacer ring and thrust plate over end of shaft, and install woodruff key in shaft keyway.

3. Install camshaft gear and press it onto the shaft until it bottoms against the gear spacer ring. Use a socket or other suitable tool. The end clearance of the thrust plate should be .001" to .005" (Fig. 6-48). If less than .001" the spacer ring should be replaced. If more than .005" the thrust plate should be replaced.

REPLACE

1. Install the camshaft assembly in the engine block, being careful not to damage bearings or cams.

2. Turn crankshaft and camshaft so that the valve timing marks on the gear teeth will line up. Push camshaft into position. Install camshaft thrust plate to block screws and tighten 5-8 ft. lbs.

3. Check camshaft and crankshaft gear runout with a dial indicator (Fig. 6-49). The camshaft gear runout should not exceed .004" and the crankshaft gear runout should not exceed .003".

4. If gear runout is excessive, the gear will have to be removed and any burrs cleaned from the shaft or the gear replaced.

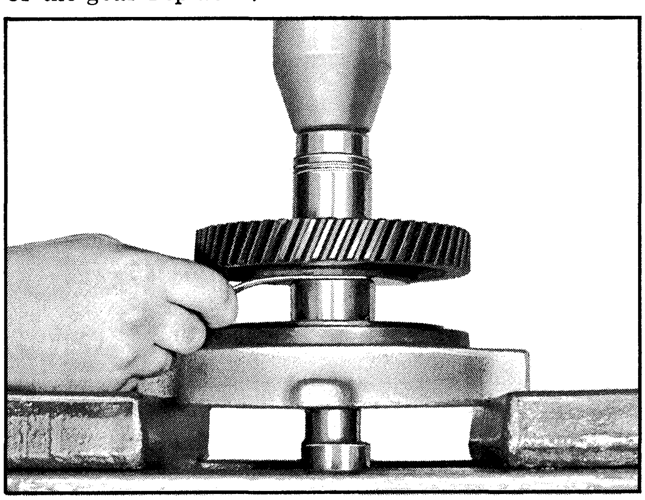


Fig. 6-48 Installing Camshaft Timing Gear and Checking Thrust Plate End Clearance

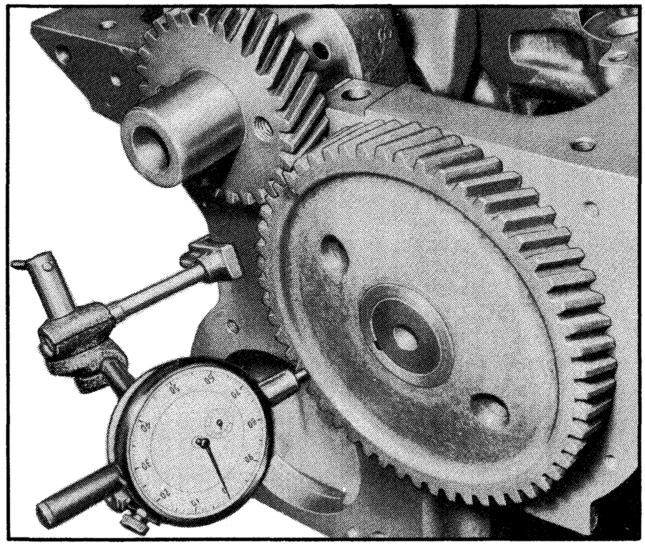


Fig. 6-49 Checking Camshaft Gear Runout

5. Check the backlash between the timing gear teeth with a dial indicator (Fig. 6-50). The backlash should not be less than .004" nor more than .006".

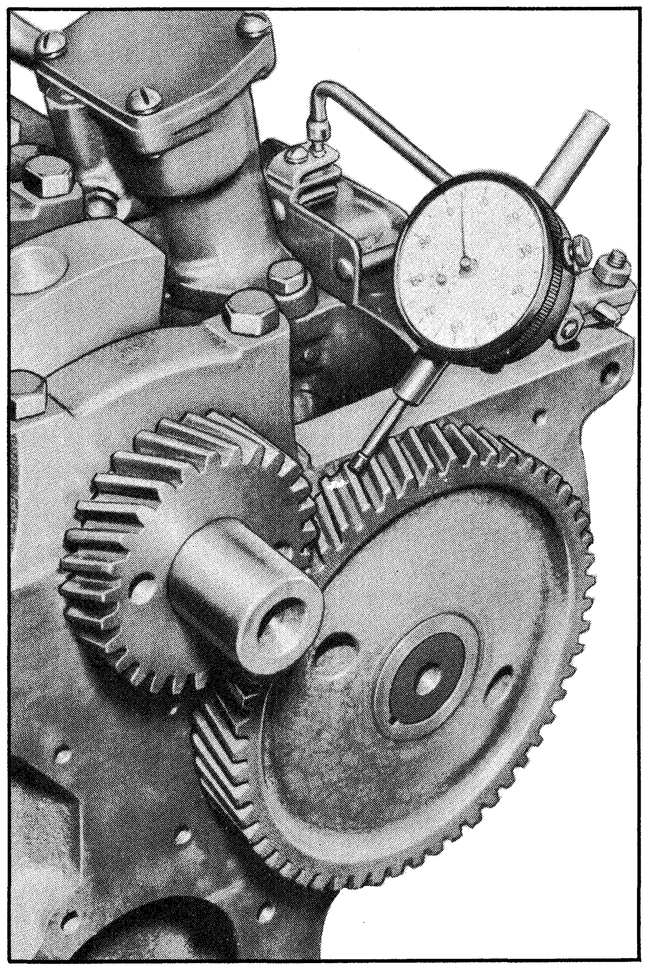


Fig. 6-50 Checking Camshaft Gear Backlash

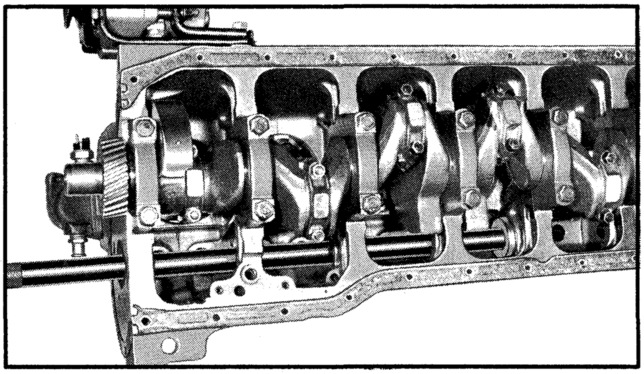


Fig. 6-51 Removing Center Camshaft Bearings

6. Install timing gear cover and gasket. Move oil pan up into position and tighten oil pan bolts.

7. Install harmonic balancer, using harmonic balancer installer tool J-8792.

8. Line up keyway in balancer with key on crankshaft and drive balancer onto shaft until it bottoms against crankshaft gear, using tool J-5590.

9. Install valve lifters and push rods. Install side cover with a new gasket. Attach coil and wires. Then install distributor as follows:

Turn crankshaft to firing position of number one cylinder (number one exhaust and intake valve lifters both on base circle of camshaft and timing mark on harmonic balancer indexed with top dead center mark on timing pad). Position new distributor to block gasket on block.

Install distributor so that vacuum diaphragm faces the front of the engine and rotor arm points toward number one cylinder spark plug contact. It will also be necessary to turn oil pump drive shaft so it will index with distributor shaft.

10. Install fuel pump.

11. Pivot rocker arms over push rods. With lifters on base circle of camshaft, tighten rocker arm nut until all valve train play is removed. Tighten nut one additional turn.

12. Install spark plugs.

13. Add oil to engine. Install water pump pulley and fan belt and adjust using tension gauge.

14. Install the radiator as described under "Engine Cooling," in Section 6A and fill cooling system.

15. Install grille assembly. See Front End Sheet Metal, Section 10.

16. Add cooling solution to radiator, start engine and check for leaks.

17. Check and adjust timing.

## CAMSHAFT BEARINGS—REMOVE AND REPLACE

### REMOVE

Camshaft bearings can be replaced while the engine is disassembled for overhaul, or without complete disassembly of the engine after camshaft and flywheel have been removed.

1. With camshaft and flywheel removed, drive out expansion plug from rear cam bearing by driving from inside.

2. Use Tool J-21473-1 to drive out front bearing toward rear and rear bearing toward front.

3. Install extension J-21054 on installer J-21473-1 and drive center two bearings out toward rear (Fig. 6-51).

### REPLACE

1. Install each new bearing on tool.

2. Install bearings by reversing removal procedure.

*NOTE: The front bearing must be driven approximately 1/8" behind front of cylinder block to uncover oil hole to timing gear oil nozzle. Align bearing oiling holes with block oiling holes and install new expansion plug.*

## OIL PAN—REMOVE AND REPLACE

### REMOVE

1. Drain cooling system and crankcase and remove engine and transmission as an assembly from vehicle. (See "Engine - Remove and Install").

2. Remove oil pan bolts, oil pan, oil pan gaskets and end seals.

REPLACE

1. Thoroughly clean all gasket sealing surfaces.

2. Install rear seal in rear main bearing cap.

3. Install front seal on timing gear cover pressing tips into holes provided in cover.

4. Install side gaskets on cylinder block using grease as a retainer. (Side gasket tabs index into notches of front seal -- Fig. 6-52).

5. Install oil pan.

*NOTE: Screws into timing gear cover should be installed last. They are installed at an angle and holes line up after rest of pan bolts are snugged up.*

6. Install engine and transmission assembly in vehicle. (See "Engine - Remove and Install").

### *OIL PUMP—REMOVE AND REPLACE*

1. Drain oil and remove oil pan as previously outlined.

2. Remove two flange mounting bolts and nut from elongated number 6 main bearing cap bolt and remove pump and screen as an assembly (Fig. 6-53).

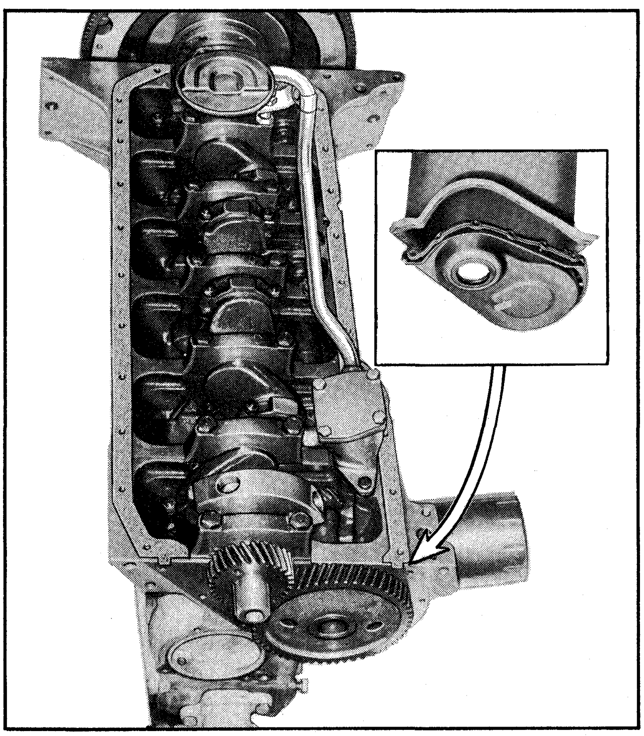


Fig. 6-52 Oil Pan Gaskets

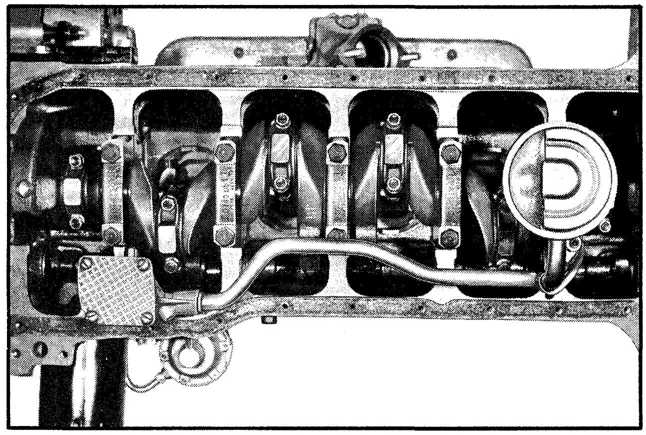


Fig. 6-53 Oil Pump Installed

3. Remove 4 cover attaching screws, cover, gasket, idler gear and drive gear and shaft (Fig. 6-54).

4. Remove pressure regulator valve and valve parts.

5. Wash all parts in cleaning solvent and dry using compressed air.

*CAUTION: Do not disturb oil pickup pipe on screen or body. This pipe is located at assembly.*

INSPECT

Should any of the following conditions be found during inspection operations, the pump assembly should be replaced.

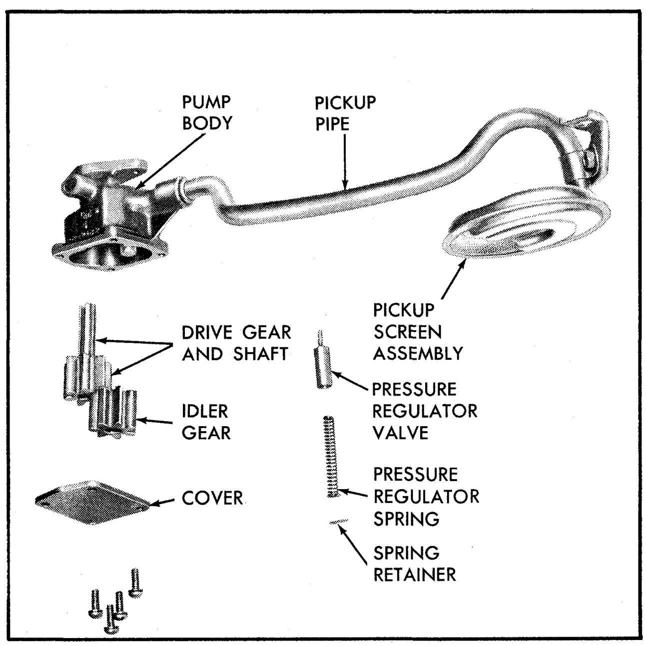



Fig. 6-54 Oil Pump - Exploded View

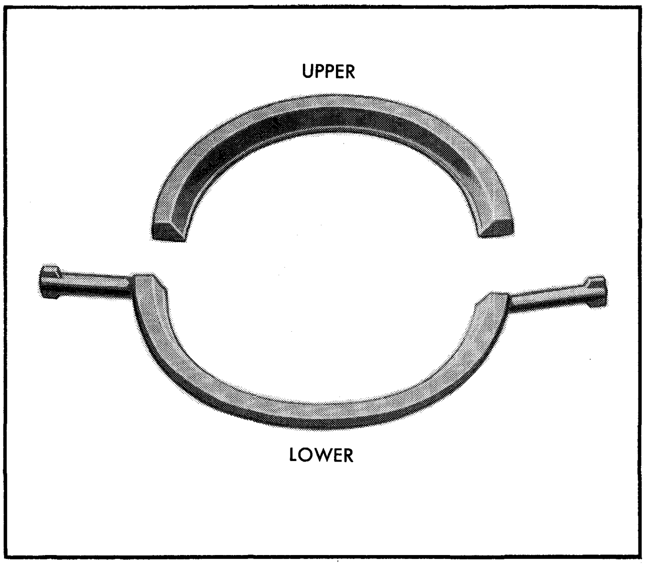



Fig. 6-55 Rear Main Bearing Oil Seal

1. Inspect pump body for cracks or excessive wear.

2. Inspect oil pump gears for excessive wear or damage.

3. Check shaft for looseness in the housing.

4. Check inside of cover for wear that would permit oil to leak past the ends of gears.

5. Check the oil pick-up screen for damage to screen, or relief grommet.

6. Check pressure regulator valve plunger for fit in body.

REPLACE

1. Place drive gear and shaft in pump body.

2. Install idler gear so that smooth side of gear will be toward the cover.

3. Install a new gasket to assure correct end clearance of the gears.

4. Install cover and attaching screws. Tighten screws 5 to 8 lb. ft. torque and check to see that shaft turns freely.

5. Install regulator valve plunger, spring, retainer and pin and install oil line to pump body loosely.

6. Align oil pump drive shaft slot to match with distributor tang, then install oil pump to block positioning flange over distributor lower bushing. Use no gasket. Tighten bolts 10-20 lb. ft.

*NOTE: Oil pump should slide easily into place. If not, remove and relocate slot or locate other problem.*

7. Install oil pan using new gaskets and seals as outlined under Oil Pan Installation.

### REAR MAIN BEARING OIL SEAL— REMOVE AND REPLACE

The rear main bearing oil seal (Fig. 6-55) can be removed (both halves) without removal of the crankshaft.

*NOTE: Always replace upper and lower seal as a unit.*

1. Drain coolant system and crankcase and remove engine from vehicle. (See "Engine - Remove and Install").

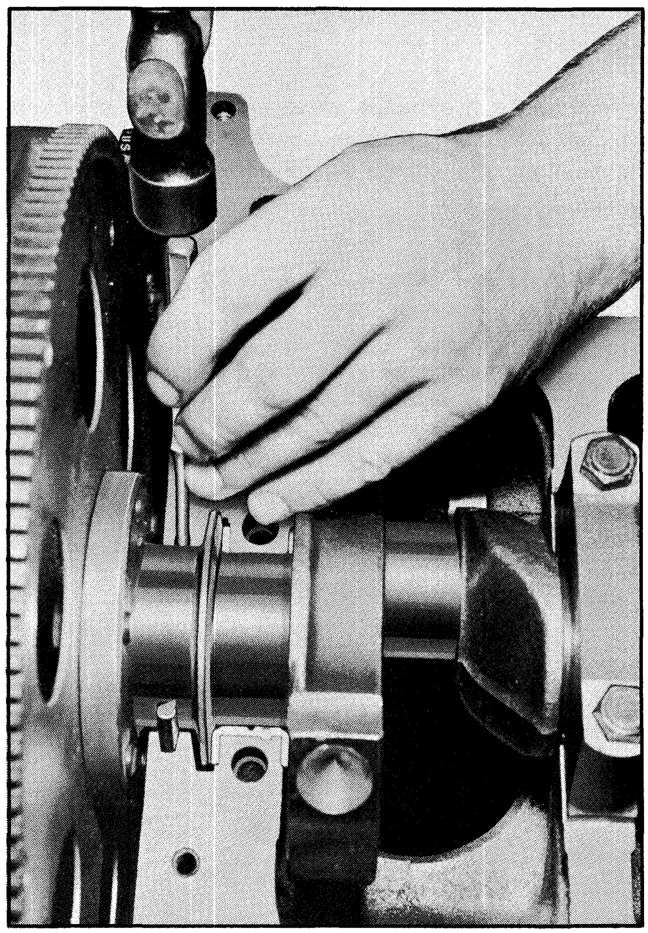


Fig. 6-56 Removing Oil Seal

2. Remove transmission, clutch (SM), and starter from engine, install engine on suitable stand and remove oil pan.

3. Remove rear bearing cap.

4. Remove oil seal from groove, prying from bottom, using a small screwdriver.

*NOTE: Always clean crankshaft surface before installing a new seal.*

5. Insert a new seal well lubricated with engine oil in bearing cap groove (keep oil off of parting line surface, this surface is treated with glue) gradually push with a hammer handle until seal is rolled into place.

6. To replace the upper half of the seal, use a small hammer and brass pin punch to tap one end of oil seal (Fig. 6-56) until it protrudes far enough to be removed with pliers (Fig. 6-56). Push new seal into place.

7. Install bearing cap and torque bearing cap bolts 60-70 ft. lbs.

8. Install oil pan.

9. Install engine in vehicle and fill crankcase and cooling system. (See "Engine - Remove and Install").

### MAIN BEARINGS—REMOVE AND REPLACE

The main bearings are of the precision insert type and do not utilize shims for adjustment. If the clearances are found to be excessive, a new standard or undersize bearing insert, both upper and lower halves, will be required.

REMOVE

1. Remove engine and transmission assembly from vehicle. Remove transmission from engine and place engine on suitable stand.

2. Remove oil pan.

3. Remove cap on main bearing requiring replacement and remove bearing from shell.

*NOTE: It may be necessary to remove oil pump when removing number 6 main bearing cap.*

4. Install a main bearing shell removing and installing tool such as KMO-734 in the oil hole in the crankshaft.

*NOTE: If such a tool is not available, a cotter pin may be bent as required to do the job (Fig. 6-57).*

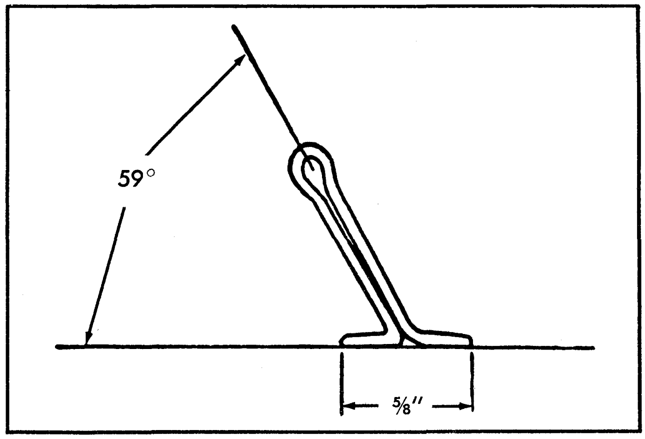



Fig. 6-57 Tool for Removing Upper Half of Main Bearing

5. Rotate the crankshaft clockwise as viewed from front of engine. This will roll upper bearing shell out of engine.

REPLACE

1. Oil new upper bearing shell and insert plain (unnotched) end of shell between crankshaft and indented or notched side. Rotate the bearing into place.

2. Install new bearing shell in bearing cap.

3. Check bearing clearance using Plastigage method as outlined below.

4. Install oil pan using new gaskets and seals.

5. Remove engine from stand.

6. Install transmission to engine.

7. Install engine and transmission assembly in vehicle.

PLASTIGAGE METHOD OF DETERMINING MAIN BEARING CLEARANCE

1. Place a .002" brass shim between the crankshaft journal and the lower bearing in each bearing cap next to the one being checked. Tighten all cap bolts to 60-70 lbs. ft. This causes the crankshaft to be forced against the upper bearing and insures an accurate measurement of the total clearance.

2. Remove the bearing cap of the bearing to be checked. Wipe the bearing and the journal free of oil.

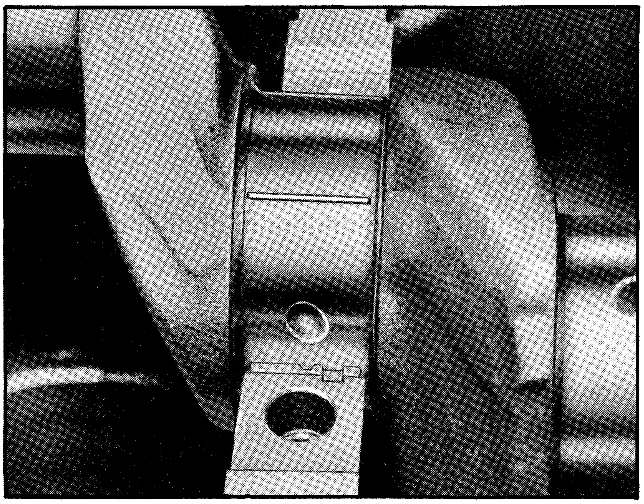


Fig. 6-58 Pastigage on Journal

3. Place a piece of Plastigage the length of the bearing (parallel to the crankshaft) on the journal or bearing surface (Fig. 6-58). Install the cap and tighten cap bolts to proper torque.

*NOTE: Do not turn crankshaft with Plastigage in place.*

4. Remove bearing cap and using Plastigage scale on envelope measure width of compressed Plastigage before removing it from the bearing or journal (Fig. 6-59). If the bearing clearance is between .0005" and .0025" the clearance is satisfactory. If the clearance is more than .0025" replace the bearing with the next undersize bearing and recheck clearance. Bearings are available in standard size, .001" and .002" undersize.

5. Install a new rear main bearing oil seal in the cylinder block and main bearing cap if the rear main bearing was checked and/or replaced.

## CONNECTING ROD BEARINGS—REMOVE AND REPLACE

Connecting rod bearing inserts are available in standard size and undersizes of .001" and .002". These bearings are not shimmed and when clearances become excessive the next undersize bearing insert should be used. DO NOT FILE ROD OR ROD CAPS.

### REMOVE

1. Remove engine and transmission assembly from vehicle. Remove transmission, clutch (SM) and starter from engine and place engine on suitable stand.

2. Remove oil pan.

3. Rotate crankshaft as necessary to bring crankpin carrying bearing to be replaced straight toward bottom of block.

4. Remove bearing cap.

5. Install connecting rod bolt guide set J-5239 on connecting rod bolts. Push piston and rod assembly up far enough to remove upper bearing.

6. Remove bearings from cap and rod.

7. Inspect crankpin for damage, out-of-round and taper.

### REPLACE

1. Reassemble cap and rod with new bearings and check clearance with Plastigage as outlined below.

2. Install oil pan using new gaskets and seals.

3. Remove engine from stand.

4. Install transmission on engine.

5. Install transmission and engine assembly in vehicle.

### PLASTIGAGE METHOD OF DETERMINING CONNECTING ROD BEARING CLEARANCE

1. Remove the cap of the bearing to be checked. Wipe the bearing and the crankpin free of oil.

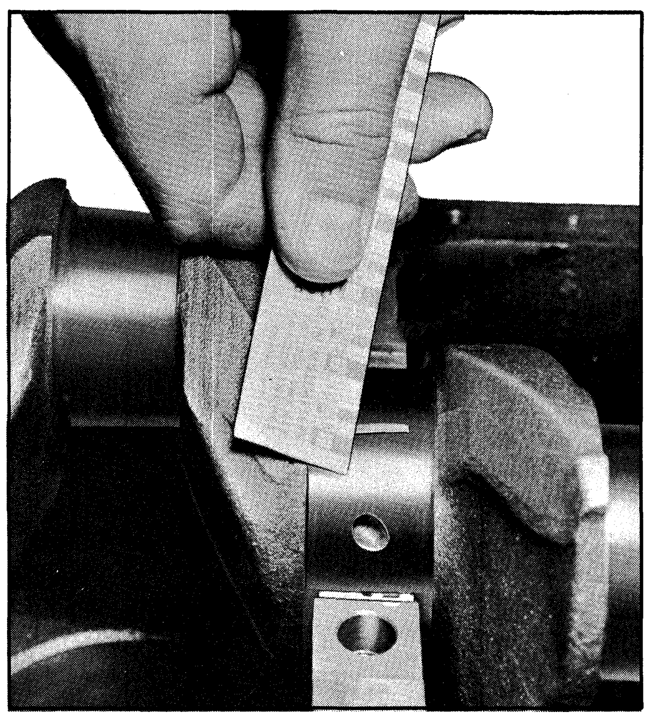


Fig. 6-59 Measure Plastigage

2. Place a piece of Plastigage the length of the bearing (parallel to the crankshaft) on the crankpin or bearing surface (Fig. 6-60). Install the cap and tighten cap bolts to 30-35 lb. ft.

*NOTE: Do not turn crankshaft with Plastigage in place.*

3. Remove bearing cap and using Plastigage scale on envelope measure width of compressed Plastigage before removing it from the crankpin or bearing (Fig. 6-61). If the bearing clearance is between .0005" and .0025" the clearance is satisfactory. If the clearance is more than .0025" replace the bearing with the next size undersize bearing and recheck clearance. Bearings are available in .001" and .002" undersize.

4. Rotate the crankshaft after bearing adjustment to be sure bearings are not tight.

5. Check connecting rod end clearance between connecting rod cap and side of crankpin (Fig. 6-62). Clearance should be .008" - .014". If clearance is more than .014", replace connecting rod.

### CONNECTING ROD AND PISTON ASSEMBLY— REMOVE AND REPLACE

REMOVE

1. Remove engine and transmission assembly from vehicle.

2. Remove transmission, clutch (SM) and starter from engine and place engine on suitable stand.

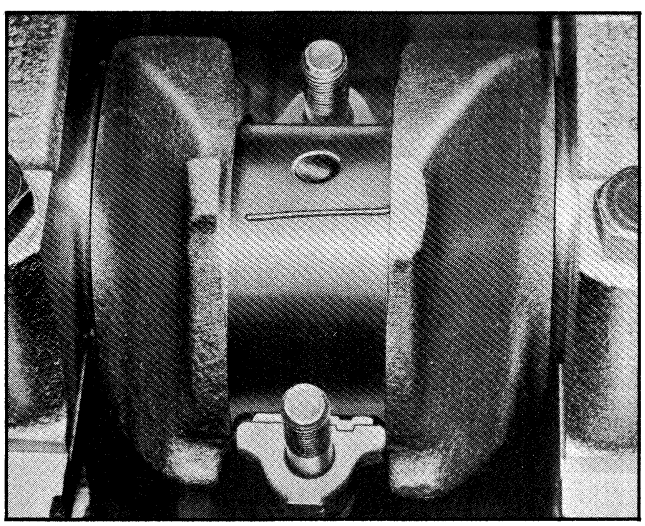


Fig. 6-60 Plastigage on Crankpin

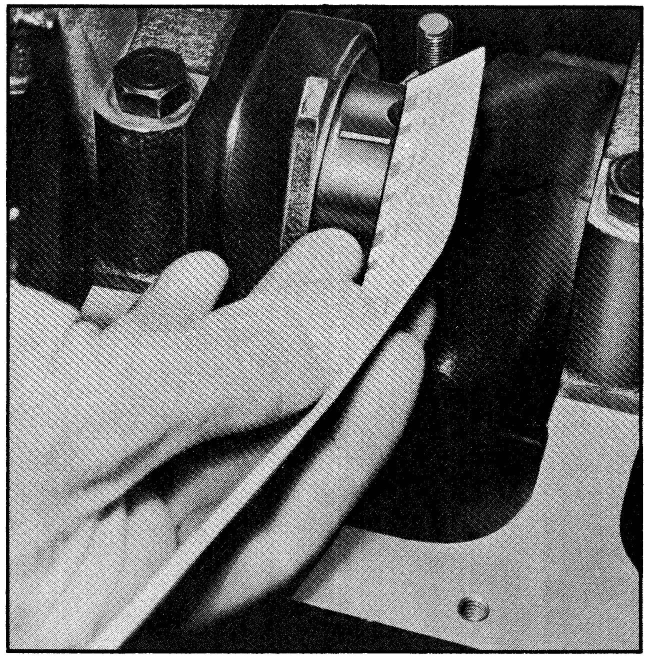


Fig. 6-61 Measure Plastigage

3. Remove rocker arm cover.

4. Loosen rocker arm nuts, rotate rocker arms and remove push rods.

5. Remove coil and push rod covers.

6. Remove valve lifters.

7. Disconnect fuel line and vacuum line at carburetor.

8. Remove cylinder head, intake and exhaust manifolds as an assembly. Remove spark plugs.

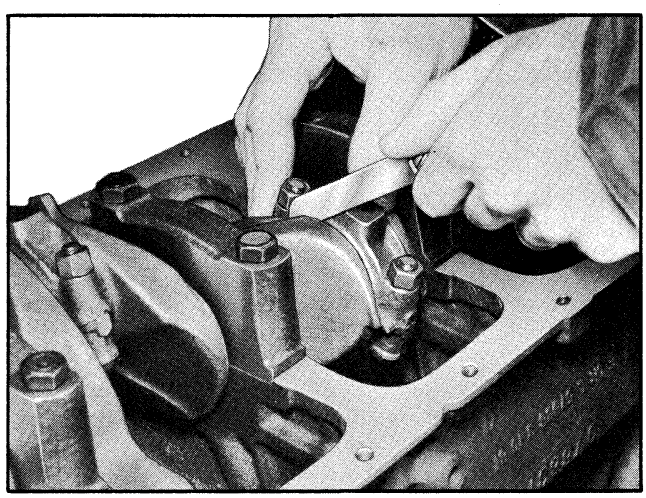


Fig. 6-62 Checking Connecting Rod Side Clearance

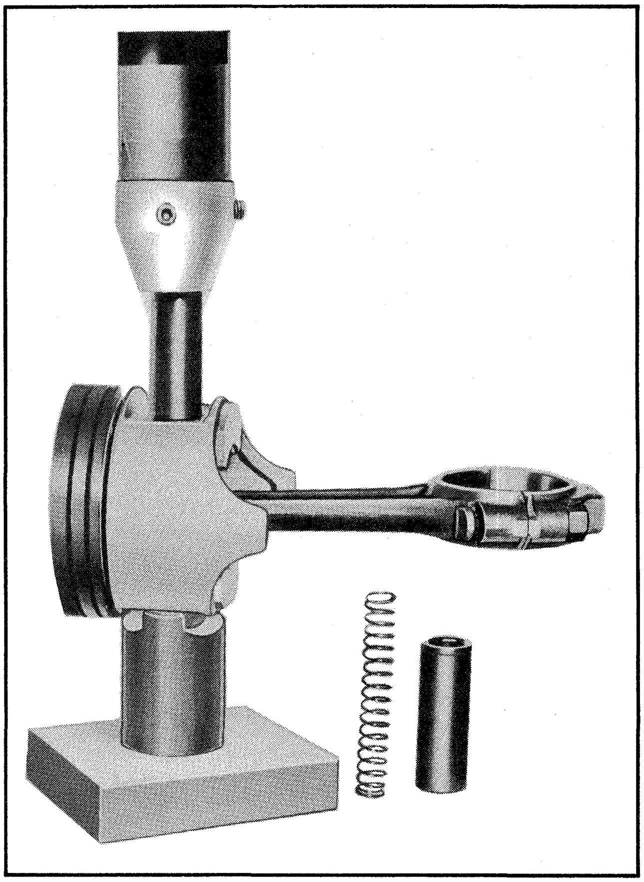


Fig. 6-63 Removing Piston Pin

9. Remove oil pan.

10. Check connecting rod and piston for cylinder number identification and if necessary, mark them.

11. Remove bearing cap and install connecting rod bolt guide set J-5239.

12. Carefully remove connecting rod and piston assembly by pushing out with knurled handle of long guide.

## CONNECTING ROD AND PISTON DISASSEMBLE

*NOTE: Use care at all times when handling and servicing connecting rods and pistons. To prevent possible damage to these units, do not clamp rod or piston in vise since they may become distorted. Do not allow pistons to strike against one another, against hard objects or bench surfaces, since distortion of piston contour or nicks in the soft aluminum material may result.*

1. Remove piston rings using suitable piston ring remover.

2. Install pilot of piston pin removing and installing tool J-9510 on piston pin.

3. Install piston and connecting rod assembly on support and place assembly in an arbor press (Fig. 6-63). Press pin out of connecting rod.

4. Remove assembly from press and remove piston pin from support and remove tool from piston and rod.

## CONNECTING ROD AND PISTON - CLEAN AND INSPECT

1. Clean carbon, varnish, and gum from piston surfaces, including underside of piston head. Clean ring grooves, and oil holes in oil ring groove, using suitable cleaning tools and solvent.

2. Clean piston pin, rod, cap, bolts and nuts in suitable solvent. Reinstall cap on connecting rod to assure against subsequent mixing of caps and connecting rods.

3. Carefully examine piston for rough or scored bearing surfaces; cracks in skirt or head; cracked, broken, or worn ring lands; and scored, galled, or worn piston bosses. Damaged or faulty pistons should be replaced.

4. Inspect piston pin for scoring, roughness, or uneven wear and proper fit.

## PISTON PIN-FIT

Piston pins are a matched fit to the piston and are not available separately. Piston pins will not become loose enough to cause a knock or tapping until after very high mileage and in such cases a new piston and pin assembly should be installed. Pistons and pins are serviced as assemblies.

The piston pin fit in piston is .0003" to .0005" loose with pin and bosses clean and dry.

*NOTE: Piston and pin must be at room temperature when checking fit and pin must be able to fall from piston by its own weight (Fig. 6-64).*

5. Inspect bearing shells to see that they are serviceable. Fit of bearings should be checked when engine is being assembled.

## CYLINDER BORES-INSPECT

Inspect cylinder bores for out-of-round or excessive taper, with an accurate cylinder gauge

J-8087 or comparable, at top, middle and bottom of bore. (Fig. 6-65). Measure cylinder bore parallel and at right angles to the center line of the engine to determine out-of-round. Variation in measure from top to bottom of cylinder indicates the taper in the cylinder. Fig. 6-66 illustrates area in cylinder where normal wear occurs. If dimension "A" is larger than dimension "B" by .007", it indicates the necessity of cylinder boring and installing new rings and pistons. Cylinder bores can be measured by setting the cylinder gauge dial at zero in the cylinder at the point of desired measurement. Lock dial indicator at zero before removing from cylinder, and measure across the gauge contact points with outside micrometer, with the gauge at the same zero setting when removed from the cylinder (Fig. 6-67).

Fine vertical scratches made by ring ends will not cause excessive oil consumption, therefore, honing to remove is unnecessary.

HONING OR BORING

If a piston in excess of .005" oversize is to be installed, the cylinder should be bored, rather than honed, to effect a true bore.

When honing to eliminate the possibility of honing taper into the cylinder when installing .005" oversize, full strokes of the hone in cylinder should be made in addition to checking measurement at top, middle and bottom of bore repeatedly.

When boring always be sure the crankshaft is out of the way of the boring cutter when boring each

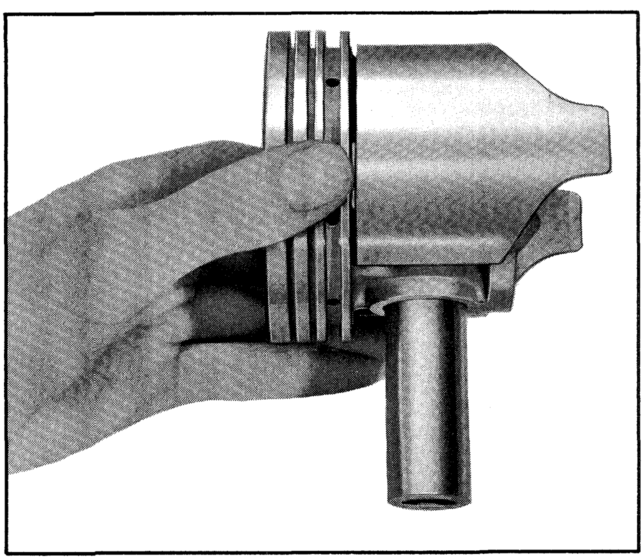


Fig. 6-64 Checking Piston Pin Fit

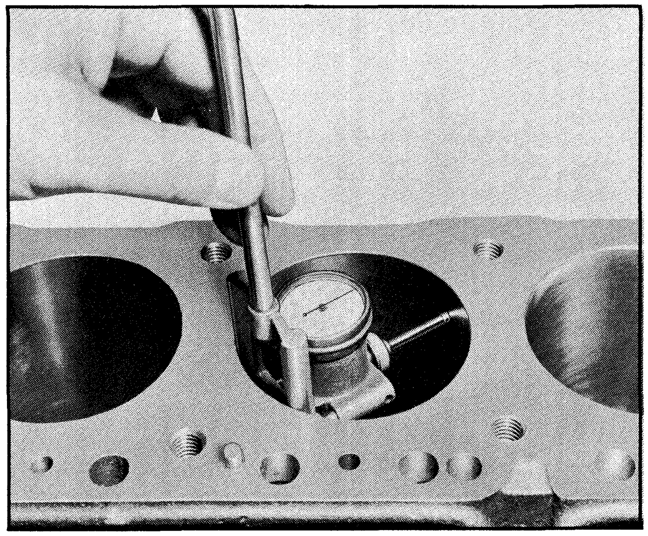


Fig. 6-65 Checking for Out-Of-Round and Taper

cylinder. Crankshaft bearings and other internal parts must be covered or taped to protect them during boring or honing operation. When taking the final cut with a boring bar leave .001" on the diameter for finish honing to give the required piston to cylinder clearance specifications.

*NOTE: Honing or boring operation must be done under close supervision so that specified clearance between pistons, rings, and cylinder bores is maintained.*

By measuring the piston to be installed at the sizing points (Fig. 6-68) and adding the mean of the clearance specification, the finish hone cylinder measurement can be determined. It is important that both the block and piston be measured at normal room temperature, 60° - 90° F.

After final honing and before the piston is checked for fit, each cylinder bore must be thoroughly

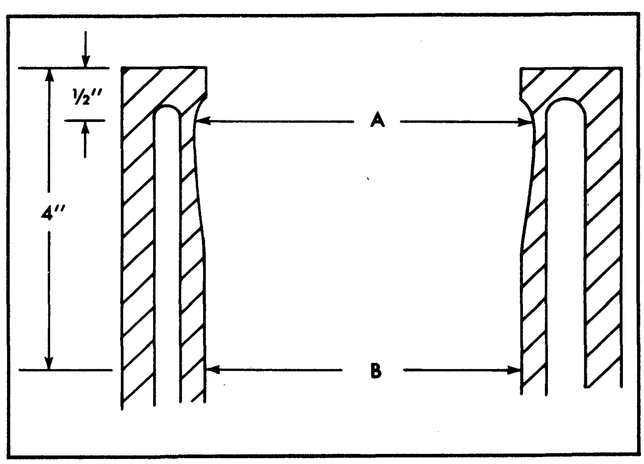



Fig. 6-66 Normal Cylinder Wear Pattern

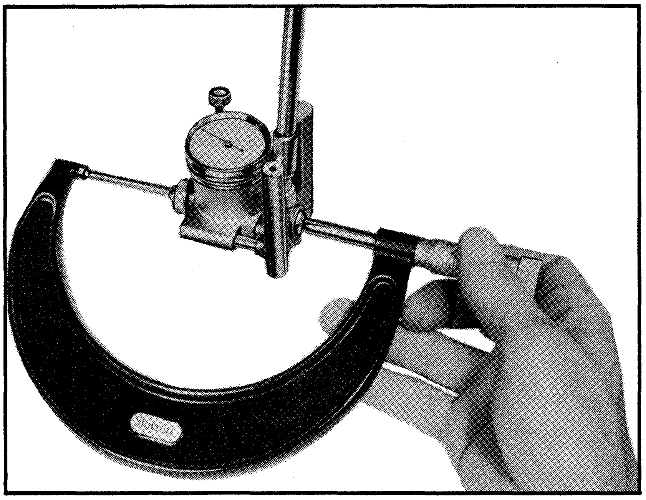


Fig. 6-67 Measuring Cylinder Gauge

cleaned. Use soapy water solution and wipe dry to remove all traces of abrasive. If all traces of abrasive are not removed, rapid wear of new rings and piston will result.

Intermixing different size pistons has no effect on engine balance as all Pontiac pistons from standard size up to .030" oversize weigh exactly the same. Pontiac does not recommend boring beyond .010" during warranty period so that if necessary, engine can be serviced at high mileage without cylinder block replacement.

PISTON - FIT AND REPLACE

Pistons should be fitted in the bores by actually measuring the fit. Clearance between the piston and the cylinder bore should be .0005" to .0011".

If cylinder bores have been reconditioned, or if pistons are being replaced, reconditioning of bores and fitting of pistons should be closely coordinated.

If bore has been honed, it should be washed thoroughly with hot, soapy water and a stiff bristle brush.

Using a cylinder checking gauge, measure the cylinder bore crosswise of the block to find the smallest diameter. Record the smallest diameter of each bore.

*NOTE: When measuring cylinder bores and pistons it is very important that the block and pistons be at room temperature. If any or all of the parts are hotter or colder than normal room temperature, improper fitting will result.*

Measure the piston skirt perpendicular to the piston pin boss (piston pin removed) and at the sizing point indicated in Fig. 6-69.

Make sure the micrometer is in full contact.

As the pistons are measured they should be marked for size identification and the measurements recorded.

If there is excessive clearance between a cylinder bore and the piston which was installed in that bore, a new piston should be used.

New pistons are serviced in standard size and .005", .010", .020" and .030" oversize.

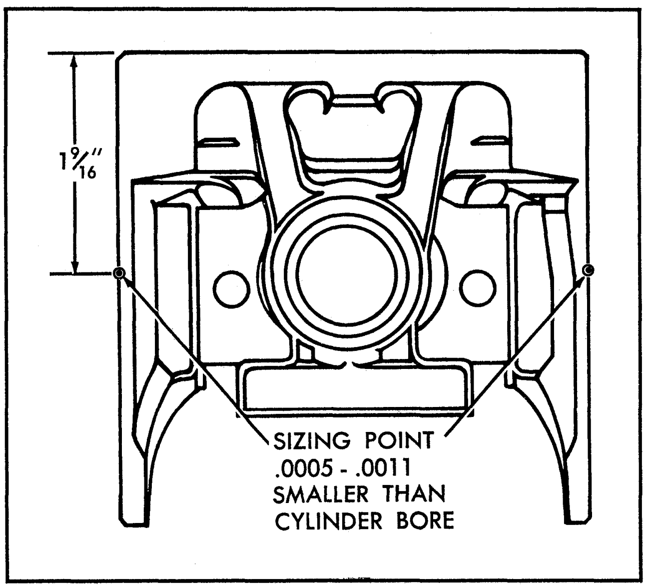



Fig. 6-68 Piston Sizing Points

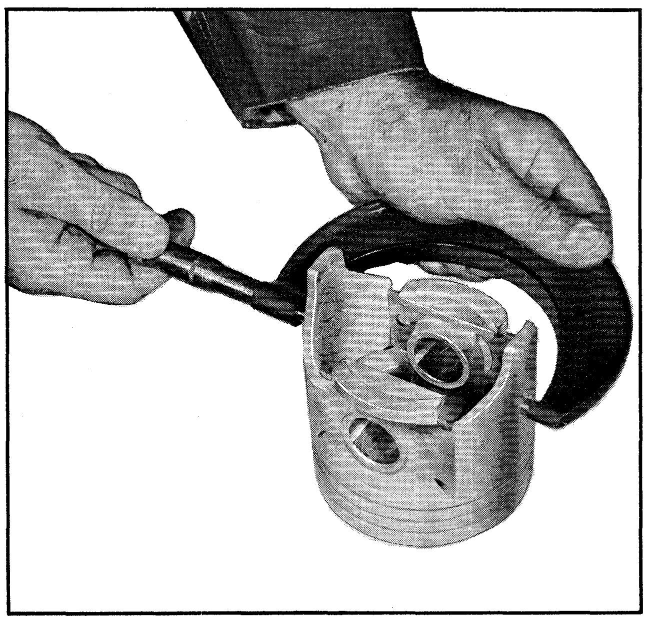


Fig. 6-69 Measuring Piston

*NOTE: Since these are nominal or basic sizes, it is important that new pistons be measured to ensure proper fit. All new pistons are serviced with selectively fitted piston pins.*

After all measurements have been made, match the new pistons with the cylinders where they will fit with proper clearance. Honing of cylinder bore may be necessary to effect a proper fit. When properly mated, mark the pistons with the cylinder numbers they fit so they will not become mixed.

CONNECTING ROD TO PISTON - ASSEMBLE

There is a notch cast in the top of all piston heads to facilitate proper installation. The piston assemblies should always be installed with the notch toward the front of the engine.

1. Lubricate piston pin holes in piston and connecting rod lightly with graphite lubricant.

2. Position connecting rod in its respective piston so that flange or heavy side of rod at bearing end will be toward front of engine (cast slot in piston top).

3. Install piston pin on installer and pilot spring and pilot in support (Fig. 6-70). Use piston pin removing and installing tool J-9510.

4. Install piston and rod on support, indexing pilot through piston and rod.

5. Place support on arbor press, start pin into position and press on installer until pin pilot bottoms.

6. Remove installer and support assembly from piston and connecting rod assembly.

7. Check piston pin for freedom of movement in piston bore.

PISTON RINGS - REPLACE

1. Remove connecting rod and piston assembly (see "Connecting Rod and Piston Assembly - Remove and Replace" in this section).

2. Clean carbon, varnish, and gum from piston surfaces, including underside of piston head. Clean ring grooves, and oil holes in oil ring groove, using suitable cleaning tools and solvent.

3. Carefully examine piston for rough or scored bearing surfaces; cracks in skirt or head; cracked, broken, or worn ring lands; scored, galled, or worn

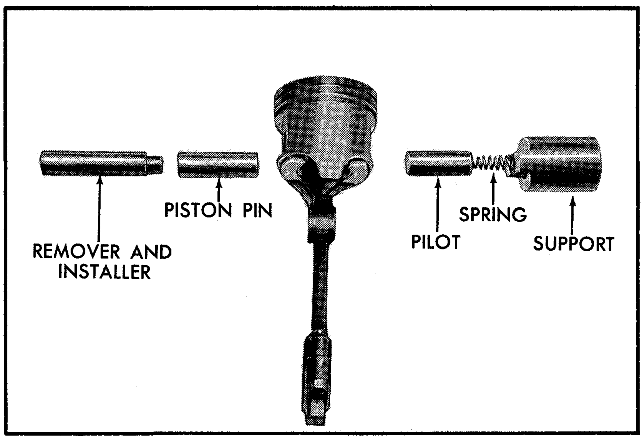



Fig. 6-70 Piston Pin Replacement

piston bosses. Damaged or faulty pistons should be replaced.

4. Inspect bearing shells to see that they are serviceable. Fit of bearings should be checked when engine is being assembled.

5. Inspect cylinder bores for out-of-round or excessive taper. If bores show excessive out-of-round or taper, or if cylinder walls are badly scored, scratched or worn beyond specified limits, the cylinder block should be rebored and new pistons and rings installed.

PISTON RINGS - INSTALL

Two compression rings and one 3-piece oil control ring, all above the piston pin, are used on pistons for both standard and premium fuel engines. The top compression rings are taper faced and also have either a step or a chamfer on the inside diameter of the top side. The top compression ring is chrome plated. The lower compression ring may have a step.

Always install compression rings with the side marked with letters "GM" toward the top of the piston.

New rings are serviced for the standard size pistons, and for .005", .010", .020", and .030" oversize pistons. When selecting rings be sure they match the size of the piston on which they are to be installed, i.e. standard rings for standard pistons, .010" oversize rings for .010" oversize pistons, etc. Ring gap and side clearance should be checked while installing rings as follows:

1. Check pistons to see that ring grooves and oil return holes have been properly cleaned.

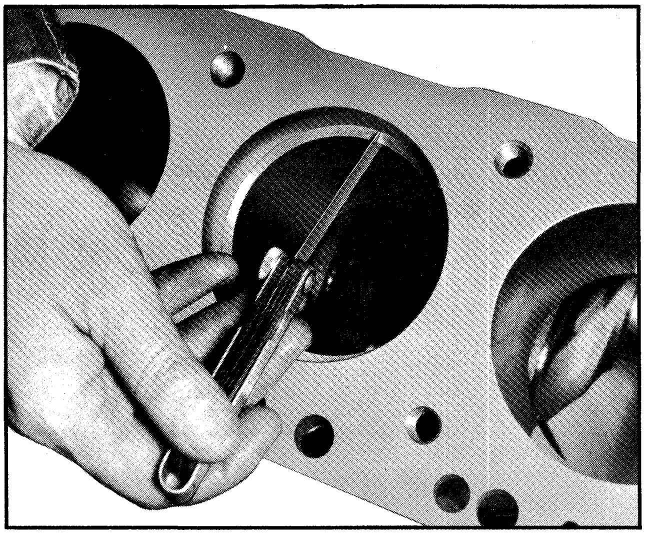


Fig. 6-71 Checking Ring Gap

2. Place ring down at the bottom of the ring traveled part of the cylinder bore in which it will be used. Square ring in bore by pushing it into position with head of piston.

3. Measure gap between ends of ring with feeler gauge (Fig. 6-71). Gaps should be as follows:

| | |
|---|---|
| Upper Compression Ring . . . . | .010" - .020" |
| Lower Compression Ring . . . . | .010" - .020" |
| Oil Ring . . . . . . . . . . . . . . . | .015" - .055" |

Incorrect ring gap indicates that wrong size rings are being used. If rings are selected according to the size of the bore (standard .005" oversize, etc.) they should have the proper gap. It should not be necessary to alter ring gap by filing.

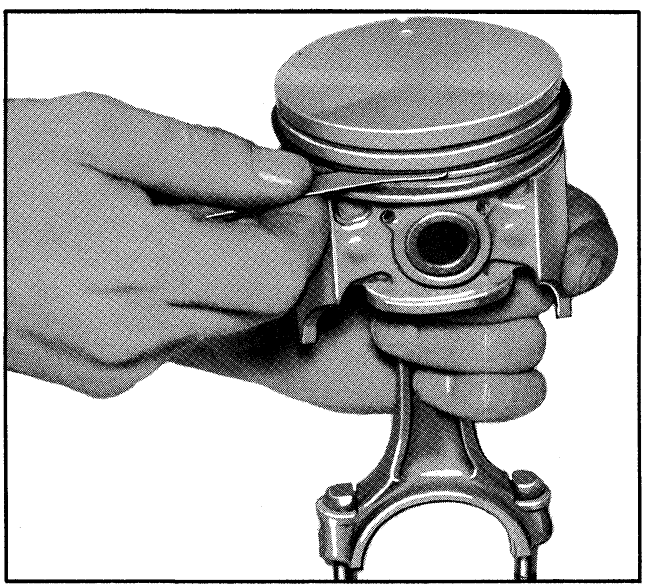


Fig. 6-72 Checking Side Clearance

4. Install rings on piston, using suitable ring installing tool, such as J-7135, to prevent breakage or fracture of rings, or damage to pistons.

5. Measure side clearance of rings in ring groove (Fig. 6-72) as each ring is installed. Clearance with new pistons and rings should be as follows:

| | |
|---|---|
| Upper Compression Ring . . . | .0015" - .0030" |
| Lower Compression Ring . . . | .0015" - .0035" |
| Oil Control Ring . . . . . . . . . | .0005" - .0055" |

If side clearance is excessive, piston should be replaced.

CONNECTING ROD AND PISTON ASSEMBLY—REPLACE

1. Install connecting rod bolt guide set J-5239 on connecting rod bolts (Fig. 6-73).

2. Using a suitable piston ring compressor insert rod and piston assembly into cylinder so that notch in top of piston is facing front of engine (Fig. 6-74).

3. From beneath engine, pull connecting rod with bearing into place against crankpin.

4. Remove guide set J-5239 and install bearing cap with oil groove facing camshaft. Tighten cap nuts to 30-35 lb. ft.

5. Install oil pan.

6. Install cylinder head, intake and exhaust manifold as an assembly.

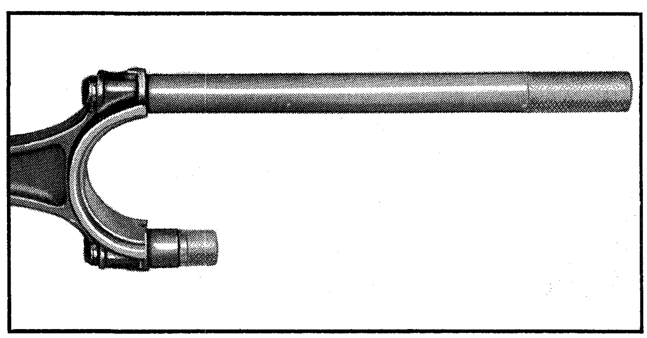


Fig. 6-73 Guide Tool J-5239 Installed

7. Connect fuel line and vacuum line to carburetor.

8. Install valve lifters.

9. Install coil and push rod covers.

10. Install push rods, move rocker arms into position and tighten rocker arm nuts.

11. Remove engine from stand.

12. Install transmission, clutch (SM) and starter to engine and install complete assembly in vehicle.

13. With lifter on base circle of camshaft, tighten rocker arm nut until all valve train play is removed. Tighten nut one additional turn.

14. Install spark plugs.

15. Install rocker arm cover.

### *CRANKSHAFT—REMOVE AND REPLACE*

REMOVE

1. Remove engine and transmission as an assembly from vehicle.

2. Remove transmission, clutch (SM) and starter from engine.

3. Mount engine on suitable stand.

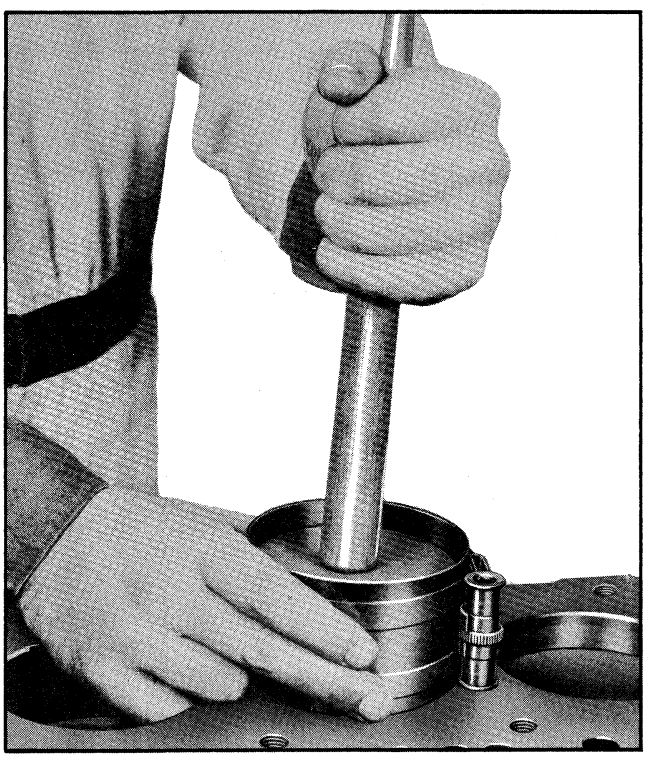


Fig. 6-74 Installing Piston in Cylinder

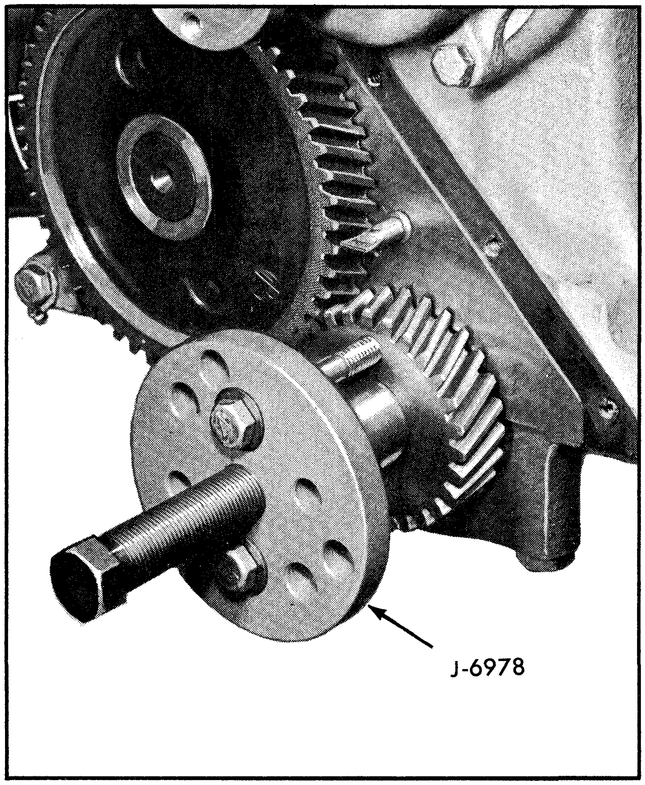



Fig. 6-75 Tool J-6978 Installed for Removing Crankshaft Timing Gear

4. Remove spark plugs.

5. Remove fan and fan pulley.

6. Remove harmonic balancer using tool J-6978.

7. Remove oil pan and oil pump assembly.

8. Remove timing gear cover.

9. Remove crankshaft timing gear with tool J-6978 (Fig. 6-75).

10. Remove connecting rod bearing caps with bearings and identify each for reinstallation.

11. Push connecting rod and piston assemblies away from crankshaft.

12. Remove main bearing caps with bearings and identify for reinstallation.

13. Remove crankshaft.

REPLACE

1. With upper bearings installed position crankshaft in block.

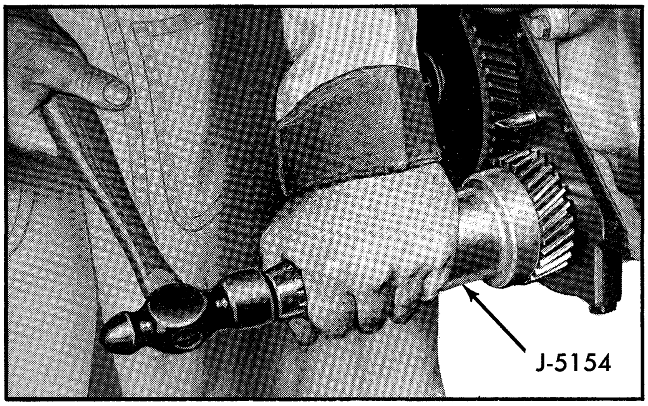



Fig. 6-76 Installing Crankshaft Timing Gear

2. Install main bearing caps (with lower bearings) but do not tighten cap bolts.

3. Pull connecting rods (with upper bearings installed) and pistons into place.

4. Install rod bearing caps (with bearings) but do not tighten nuts.

5. Tighten main bearing caps 60-70 lb. ft.

6. Tighten connecting rod bearing caps 30-35 lb. ft.

7. Install key from old crankshaft keyway in new crankshaft.

8. Install crankshaft timing gear with installer tool J-5154 (Fig. 6-76).

*IMPORTANT: ALIGN TIMING MARKS ON TIMING GEARS BY ROTATING CRANKSHAFT IF NECESSARY.*

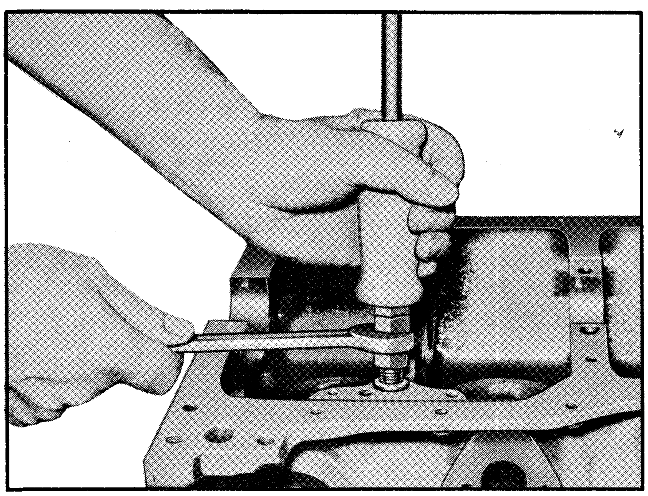


Fig. 6-77 Removing Distributor Lower Bushing

9. Install timing gear cover using new seal and gaskets.

10. Install oil pump assembly and oil pan using new rear seal in rear main bearing cap and new front seal on timing gear cover. Press front seal tips into holes in timing gear cover.

11. Coat front cover oil seal contact area of balancer with oil and drive balancer into position using balancer installer tool X-8792.

12. Install fan pulley and fan.

13. Install spark plugs.

14. Remove engine from stand.

15. Attach clutch (SM), transmission and starter to engine.

16. Install complete assembly in vehicle.

### DISTRIBUTOR LOWER BEARING—REMOVE AND REPLACE

The distributor lower bearing is a bronze bushing pressed into the lower side of the engine block. Its upper inside diameter pilots the distributor shaft and the outside diameter extending below the block pilots the oil pump.

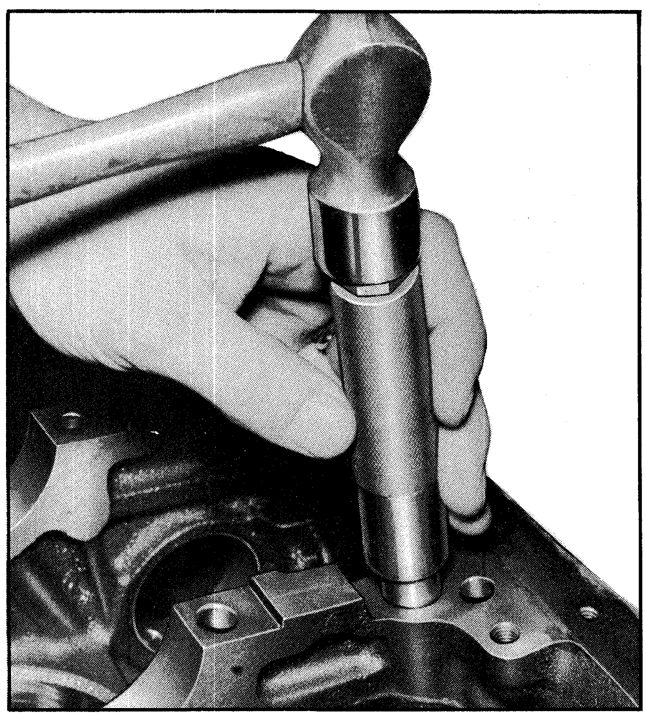


Fig. 6-78 Installing Distributor Lower Bushing

The lower bushing will ordinarily require only a clearance or wear check during engine overhaul. When distributor shaft-to-bushing clearance exceeds .0035", the bushing should be replaced as follows with oil pump and distributor removed.

REMOVE

1. Install tool J-9534 into bushing and using a slide hammer, remove the bushing (Fig. 6-77).

2. Clean bushing bore in block and check for burrs or damage.

REPLACE

1. Using tool J-9535 with driver-bolt in driver handle or other suitable tool, install new bushing (Fig. 6-78).

### *FITTED BLOCK ASSEMBLY—REPLACE*

Fitted block assembly contains pistons, rings, pins, camshaft bearings, main bearings, oil filter by-pass valve and distributor lower bearing.

DISASSEMBLE

1. Remove engine and transmission as an assembly from vehicle.

2. Remove transmission, clutch (SM) and starter from engine.

3. Install engine in suitable stand.

4. Remove ground strap and dipstick.

5. Disconnect spark plug wires and primary wire at coil.

6. Remove distributor hold down clamp and vacuum advance line and remove distributor and base gasket.

7. Remove spark plugs and coil.

8. Disconnect fuel line at fuel pump and remove fuel pump.

9. Remove push rod cover retaining screws, their gaskets, covers and cover gaskets.

10. Remove oil pressure sending switch, oil filter and oil filter connector.

11. Disconnect fuel and vacuum lines at carburetor.

12. Remove the lines by sliding them from the retaining clip at the cylinder head water outlet.

13. Remove generator mounting bolts, generator, fan belt and generator mounting bracket.

14. Remove fan and water pump pulley.

15. Remove water pump.

16. Remove harmonic balancer with tool J-6978.

17. Remove timing gear cover.

18. Remove crankshaft timing gear with tool J-6978 and remove crankshaft key.

19. Remove rocker arm cover.

20. Loosen and rotate rocker arms.

21. Remove push rods and valve lifters and store in stand J-5709 and box J-5763 in numerical order.

22. Remove cylinder head, intake and exhaust manifolds as an assembly.

23. Remove two camshaft thrust plate screws through holes in the camshaft gear and remove camshaft through the front of the block.

24. Remove starter.

25. Remove oil pan.

26. Remove oil pump and dipstick tube.

27. Remove crankshaft.

28. Remove all connecting rod and piston assemblies and identify each connecting rod according to cylinder from which it was removed.

29. Remove connecting rods from pistons.

30. Remove old block from stand and mount new block on stand.

31. Remove new piston and pin assemblies from new block and identify each according to cylinder from which it was removed.

This completes disassembly for partial engine replacement. Use new gaskets and pay special attention to torque requirements.

ASSEMBLE

1. Assemble old connecting rods to new piston and pin assemblies according to cylinders from which they were removed.

2. Install connecting rod and piston assemblies in proper cylinders.

3. Install crankshaft.

*NOTE: New fitted block contains fitted upper main bearings and standard lower main bearings. It is necessary to check crankshaft to bearing clearance with Plastigage when installing the crankshaft. Replace main bearings with undersize bearings if necessary.*

4. Install oil pump over distributor lower bearing and bolt in place. Tighten 9 to 11 lb. ft.

5. Install camshaft with camshaft gear. Attach thrust plate with screws and tighten to 6-7-1/2 lb. ft.

6. Install crankshaft key and install crankshaft timing gear with timing marks aligned.

7. Install timing gear cover oil seal in cover with tool J-5154.

8. Install timing gear cover gasket on block with grease and install cover over centering tool J-0966. Install cover screws and torque to 6-7-1/2 lb. ft. Remove centering tool.

9. Install harmonic balancer.

10. Install oil pan with new gaskets and seals.

11. Install starter.

12. Install cylinder head, intake and exhaust manifolds as an assembly. Torque cylinder head bolts to 90-95 lb. ft. Use new cylinder head gasket.

13. Install valve lifters, push rods and push rod covers.

14. Install distributor as follows:

Turn crankshaft to firing position of number one cylinder (number one exhaust and intake valve lifters both on base circle of camshaft and timing mark on harmonic balancer indexed with top dead center mark on timing pad). Position new distributor to block gasket on block.

Install distributor so that vacuum diaphragm faces the front of the engine and rotor arm points toward number one cylinder spark plug contact. It will also be necessary to turn oil pump drive shaft so it will index with distributor shaft.

15. With camshaft of base circle for each cylinder, tighten rocker arm nuts until all valve train play is removed. Then tighten nut one additional turn.

16. Install spark plugs, coil, distributor cap and high tension wires.

17. Install water pump.

18. Install generator mounting bracket.

19. Install fan and fan pulley. Tighten bolts 5-6 lb. ft.

20. Install generator and fan belt.

21. Install fuel pump and tighten bolts to 10-15 lb. ft.

22. Install oil pressure sending switch.

23. Install vacuum and fuel lines and connect them to the fuel pump, distributor and carburetor.

24. Install ground strap, dipstick tube and dipstick.

25. Remove engine from stand and install flywheel, clutch (SM), transmission, and starter. Tighten flywheel to crankshaft bolts 50-65 lb. ft.

26. Install engine, clutch (S-M) and transmission as an assembly in vehicle.

# EIGHT CYLINDER ENGINE (V-8)



## GENERAL DESCRIPTION

Two optional V-8 engines (Fig. 6-79), with 326 cubic inch displacement are available on special order. These engines have a 3-23/32" bore and 3-3/4" stroke. The compression ratios are 8.6:1 and 10.5:1.

### *CYLINDER BLOCK*

The cylinder block has two banks of four cylinders each, cast at 90° to each other. Left bank cylinders are numbered 1-3-5-7 and right bank cylinders are numbered 2-4-6-8.

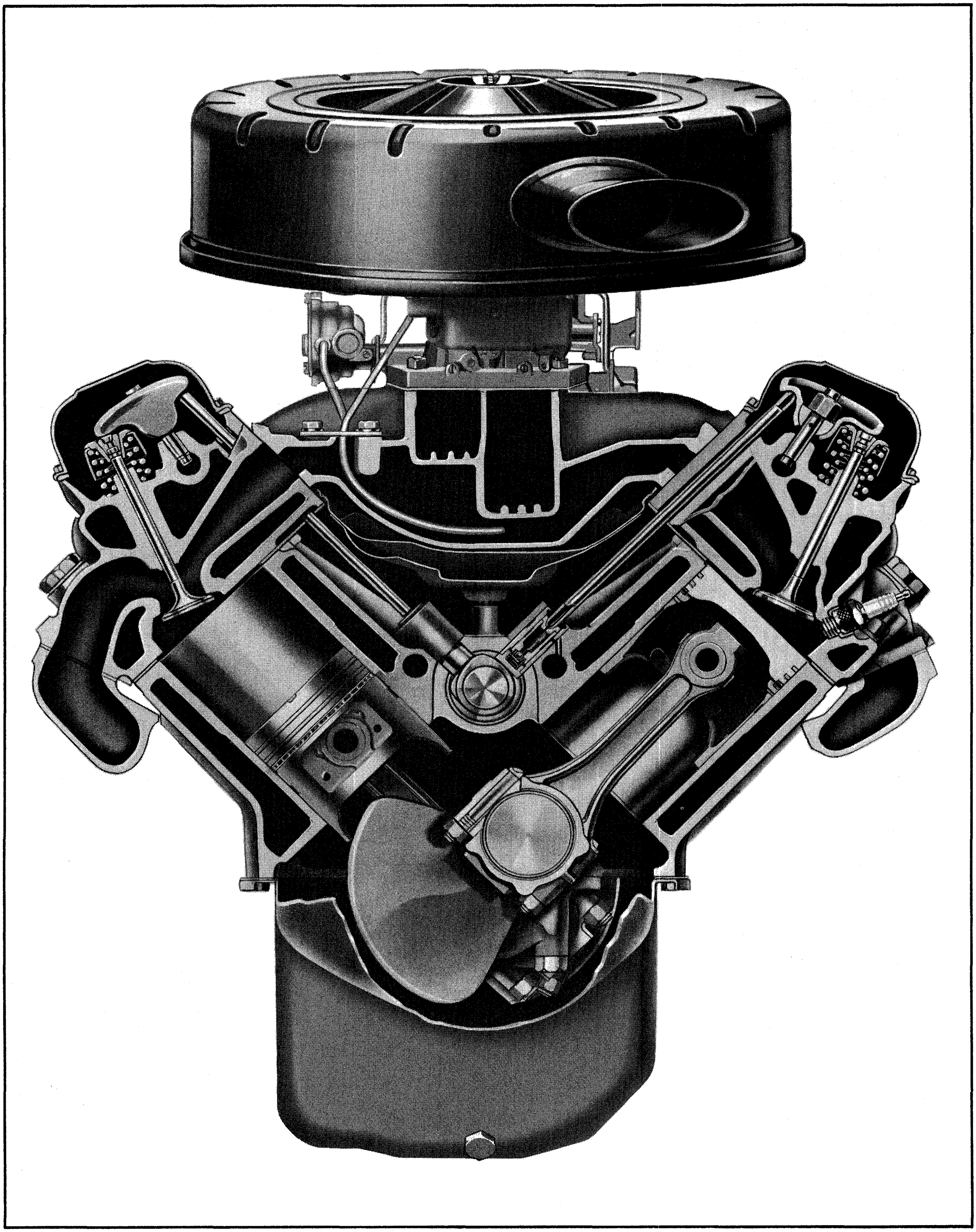


Fig. 6-79 Tempest 326 Cu. In. V-8 Engine

The left bank is set slightly behind the right bank. This provides room for mounting the fuel pump in front of the engine on the left side where it receives direct cooling from the fan (Fig. 6-79). Also, it permits a shorter fuel line. Both these factors minimize the possibility of vapor lock. This arrangement of cylinders also provides for mounting the alternator on the right side. This location is advantageous since it places the most severe turn in the belt on the slack, or lowest tension side, of the belt.

All main bearing caps are doweled to the cylinder block to assure accurate alignment and facilitate assembly (Figs. 6-80, 6-81).

Cylinders are completely encircled by water jackets. For details of the engine cooling system see ENGINE COOLING AND LUBRICATION.

### CYLINDER HEADS

Left and right cylinder heads are identical. The same casting is used for both heads.

Different heads are used on 8.6:1 and 10.5:1 compression ratio engines.

Valve seats are completely surrounded by water and each head has an oil gallery which feeds oil to the rocker arm studs to provide lubrication of the upper valve train parts.

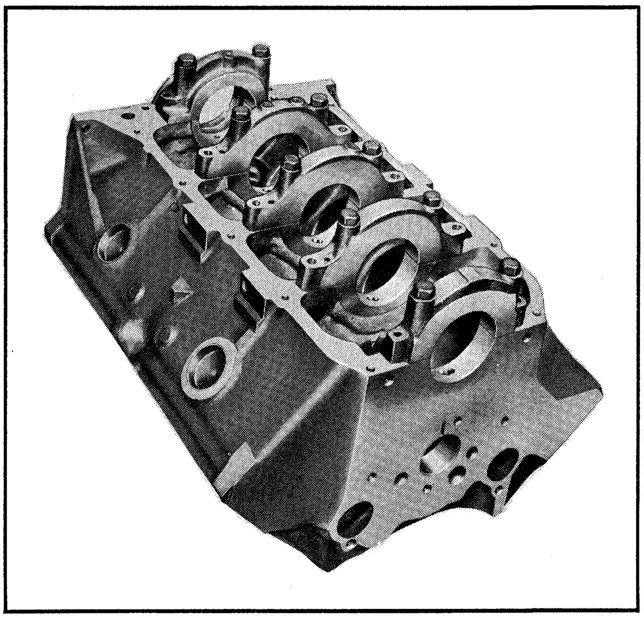


Fig. 6-80 Cylinder Block and Bearing Caps

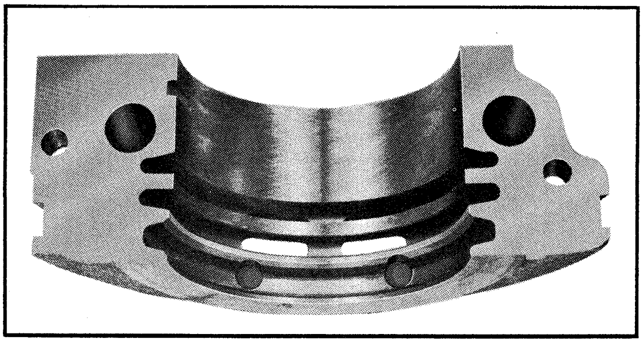


Fig. 6-81 Rear Main Bearing Cap

Cylinder head casting date is located at the right front corner of the right head and the left rear corner of the left head.

### CRANKSHAFT AND BEARINGS

The crankshaft is cast pearlitic malleable iron and is supported by five main bearings. The rear main bearing shells have two oil grooves. The rear oil groove has three oil drain holes evenly spaced. The front four upper and lower shells are not interchangeable, due to omission of an oil groove in lower half. Torsional vibration is dampened by the harmonic balancer mounted on the front end of the crankshaft.

The rear main bearing is sealed by a packing seated in a chamfered groove in the block and bearing cap (Fig. 6-81). A slinger on the crankshaft in front of the seal and the drain groove in the rear main bearing prevent an excess of oil from getting to the seal.

Slots are cast in the cylinder block and cap seal groove to prevent seal rotation.

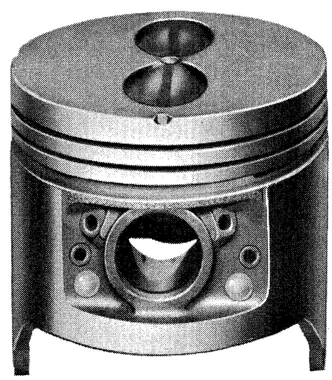



Fig. 6-82 Piston

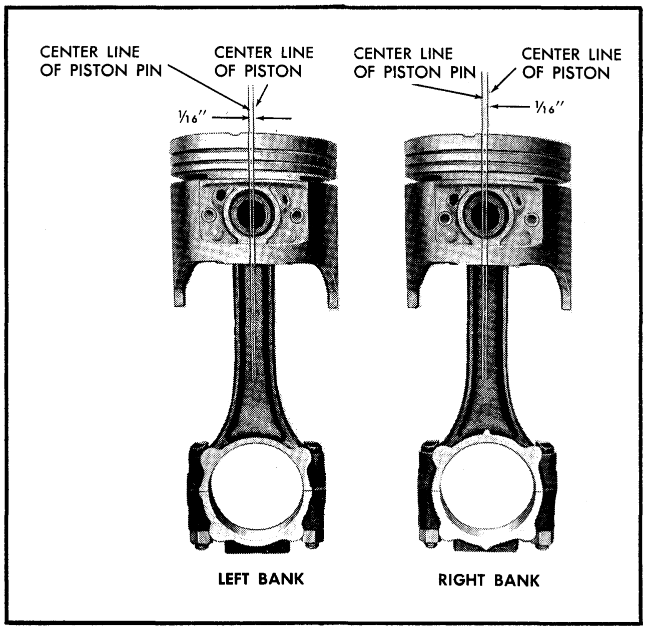



Fig. 6-83 Connecting Rod and Piston Assembly

### CAMSHAFT AND DRIVE

The camshaft is cast from alloy iron. Cam lobes are ground, hardened and tapered with the high side toward the rear. This, coupled with a spherical face on the lifter causes valve lifters to rotate. The camshaft is supported by five bearings.

A 7/8" wide, 60 link timing chain is used to drive the camshaft. The 42 tooth camshaft drive sprocket is made from cyanide hardened, cast alloy iron, while the 21 tooth crankshaft sprocket is made from case hardened steel.

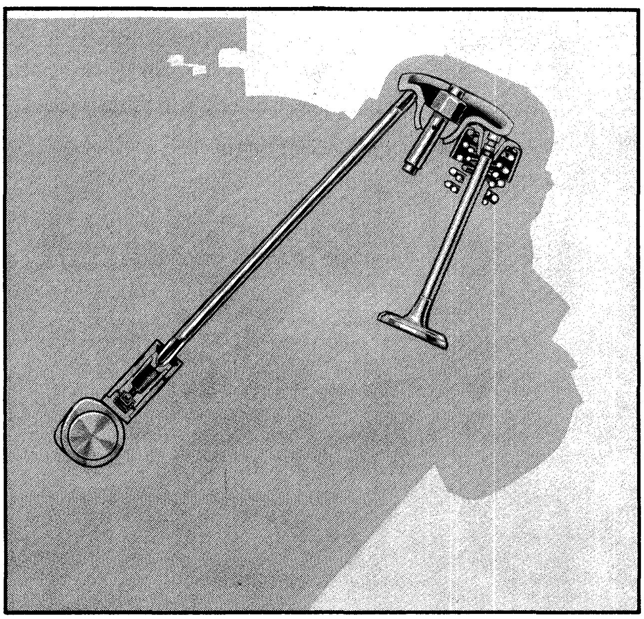


Fig. 6-84 Valve Train

### PISTONS AND CONNECTING RODS

The pistons are aluminum alloy, tin plated, with steel struts to control expansion and give added strength (Fig. 6-82). Pistons are cam ground so that the diameter across the thrust face is larger than the diameter fore and aft of the engine. The steel struts give assurance that the piston will expand front to rear and that the thrust diameter will not change. Two compression rings and one oil control ring are used, all of which are located above the piston pin.

The top of the piston has a relief machined into the head for valve clearance.

Piston pins are offset 1/16" toward thrust side (right hand side) to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path (Fig. 6-83). This feature provides quieter engine operation. Pins are hardened steel and have a floating fit in the pistons. They are retained in the connecting rods by a press fit.

A lubrication groove between the connecting rod and cap directs a jet of oil onto the opposite cylinder wall to lubricate the piston and rings and to provide splash for lubricating the piston pins.

### VALVE TRAIN

A very simple ball pivot type valve train is used (Fig. 6-84). Motion is transmitted from the camshaft through the hydraulic lifter and push rod to

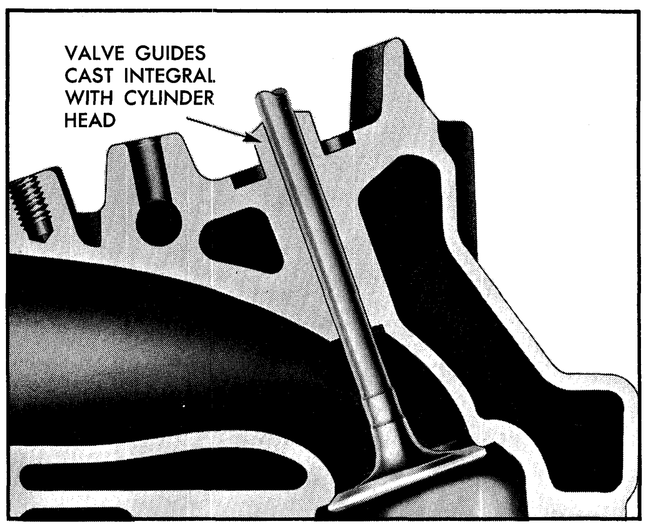



Fig. 6-85 Intake Valve Guide

the rocker arm. The rocker arm pivots on its ball and transmits the camshaft motion to the valve. The rocker arm ball is retained by a nut which locks against a chamfer on the stud.

The maximum in durability is assured by the use of cyanide-hardened stamped steel rocker arms. In addition all friction points to the valve train are positively lubricated.

The cylinder head has straight valve guides cast integral (Fig. 6-85). External shields are used on both intake and exhaust valves to reduce the amount of oil splashed against stems. Valve stem seals are used on exhaust as well as intake valves to prevent oil from entering the valve guides.

Inner and outer valve springs are used on all engines.

### *HYDRAULIC VALVE LIFTERS*

Hydraulic lifters are used to keep all parts of the valve train in constant contact. In other words each lifter is an automatic adjuster maintaining zero lash under all conditions. This insures precision valve timing and silent operation, increases valve life, and eliminates the need for tappet adjustment.

The hydraulic lifter assembly (Fig. 6-86) includes: the cast iron body which rides in the cylinder block

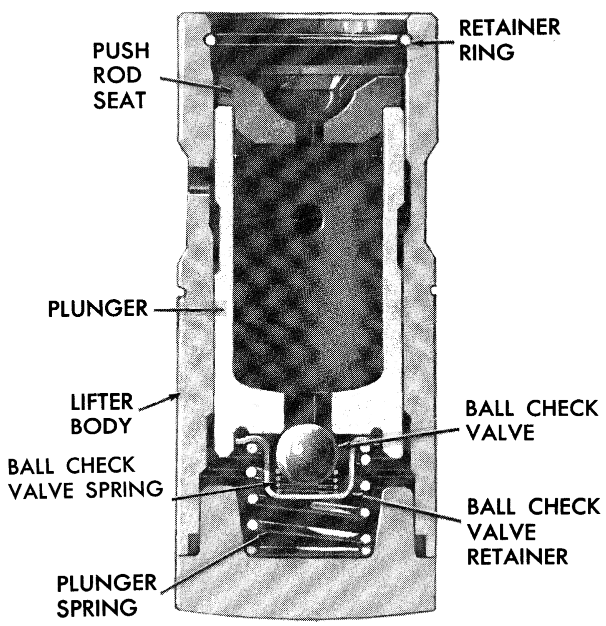



Fig. 6-86 Sectional View Valve Lifter Assembly

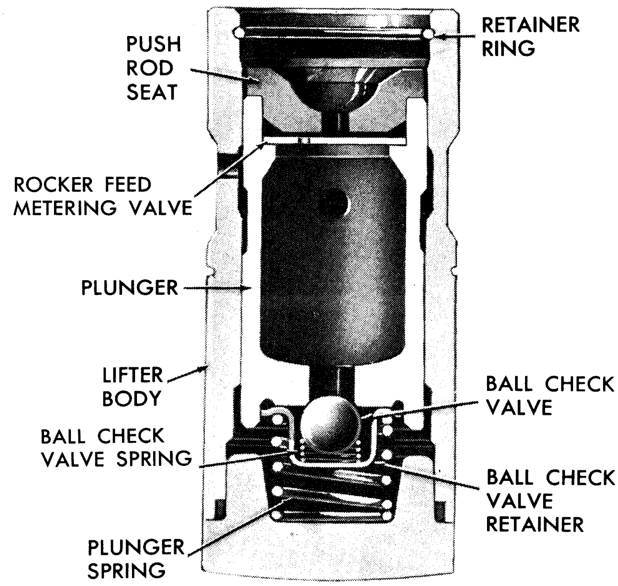



Fig. 6-87 Sectional View - Valve Lifter - 326 H.O. with Synchromesh

boss, the plunger, push rod seat, plunger spring, ball check valve, ball check valve retainer, and retainer ring.

The hydraulic valve lifter functions as follows: When the lifter is riding on the low point of the cam, the plunger spring keeps the plunger and push rod seat in contact with the push rod.

When the lifter body begins to ride up the cam lobe, the ball check valve cuts off the transfer of oil from the reservoir below the plunger. The plunger and lifter body then rise as a unit pushing up the push rod and opening the valve.

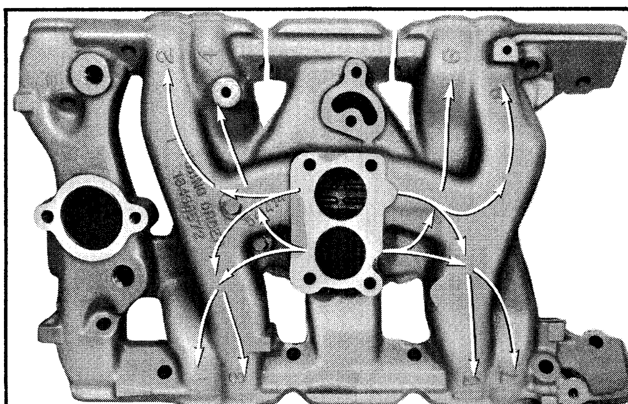


Fig. 6-88 Intake Manifold - Two Barrel Carburetor

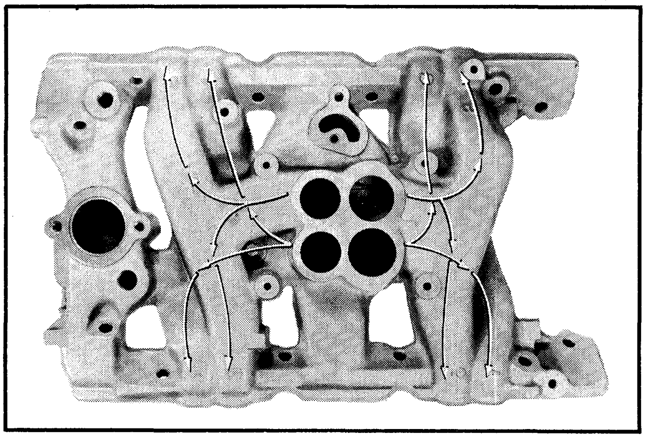


Fig. 6-89 Intake Manifold - Four Barrel Carburetor

As the lifter body rides down the other side of the cam the plunger follows with it until the valve closes. The lifter body continues to follow the cam to its low point, but the plunger spring keeps the plunger in contact with the push rod. The ball check valve will then move off its seat and the lifter reservoir will remain full.

During operation a small amount of oil leaks out of the lifter between the plunger and body. A controlled amount of leakage is important to provide continuous adjustment of the plunger position within the lifter. This leakage is called "leak down" and must be within certain limits to provide correct operation.

Oil is supplied to the lifter by the cylinder block oil gallery to replace that lost through leak down. The annular groove around the outside of the lifter body indexes with the passage drilled from the gallery to the lifter boss. Oil then enters the lifter from this groove and passes into the plunger cavity. From the plunger cavity, oil under pressure is also fed up the push rod to lubricate the friction area between the upper end of the push rod and the rocker arm.

A special hydraulic valve lifter is used in 326 H.O. engines with synchromesh transmission (Fig. 6-87). This special lifter incorporates a spring loaded check ball to allow higher engine RPM.

### FUEL DISTRIBUTION SYSTEM

The intake manifold is designed to provide fuel passages which are short and practically equal in length. With the two barrel carburetor each throat of the carburetor feeds four cylinders as shown in Fig. 6-88. The intake manifold used with the four barrel carburetor is fundamentally the same as with the two barrel but has four openings to index with the carburetor throats. With the four barrel carburetor the two throats on the right side feed four cylinders and the two throats on the left side feed four cylinders (Fig. 6-89).

A stove is included in the intake manifold surrounding the risers which lead to the carburetor. When the engine is cold, exhaust gases from the right bank of cylinders pass through a passage in the intake manifold to circulate around and heat the stove. The fuel-air mixture passing from the carburetor to the cylinders is thereby pre-heated to the desired temperature for proper combustion.

### EXHAUST SYSTEM

Two cast iron exhaust manifolds are used, one for each bank of cylinders. A one-piece Y-shaped exhaust pipe assembly is used to direct exhaust gases from each exhaust manifold to the muffler and tailpipe. A thermostatically controlled valve in the outlet of the right exhaust manifold blocks the passage of exhaust gases out of this manifold when the engine is cold. Exhaust from the cylinders on the right bank will then pass through the intake manifold exhaust crossover passage and out the left cylinder head and exhaust manifold.

In passing through the intake manifold crossover passage, the hot gases serve to heat the intake manifold stove.

### COMBUSTION CHAMBERS

Combustion chambers are completely machined to insure accurate volume control and uniform snape

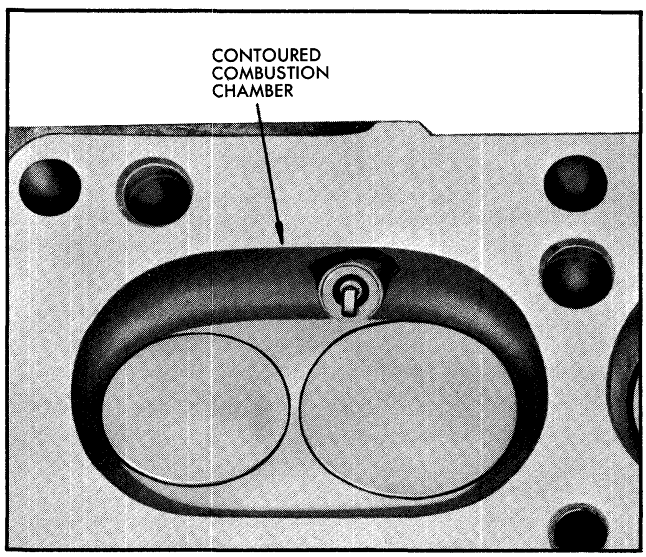



Fig. 6-90 Combustion Chamber

for all cylinders. Spark plugs are located near intake valves for maximum power and to properly fire economically lean mixtures.

The contoured wedge shape of the combustion chamber (Fig. 6-90) minimizes the possibility of detonation, facilitates breathing and provides swirling turbulence for smooth, complete combustion.

Intake valves are large and have 30° seat angles to further provide easy breathing for high combustion efficiency. Exhaust valve seat angle is 45°.

### SERIAL NUMBERS

The manufacturer's engine identification number is located on a machined pad on the front of the right-hand bank of the block (Fig. 6-91).

This number is used for production control purposes during manufacture. The production engine number should be included on AFAs or PI Reports concerning the engine.

## GENERAL INFORMATION ON ENGINE SERVICE

Cleanliness is a primary factor when servicing the V-8 engine. The slightest particle of dirt that finds its way into a hydraulic lifter may cause a malfunction.

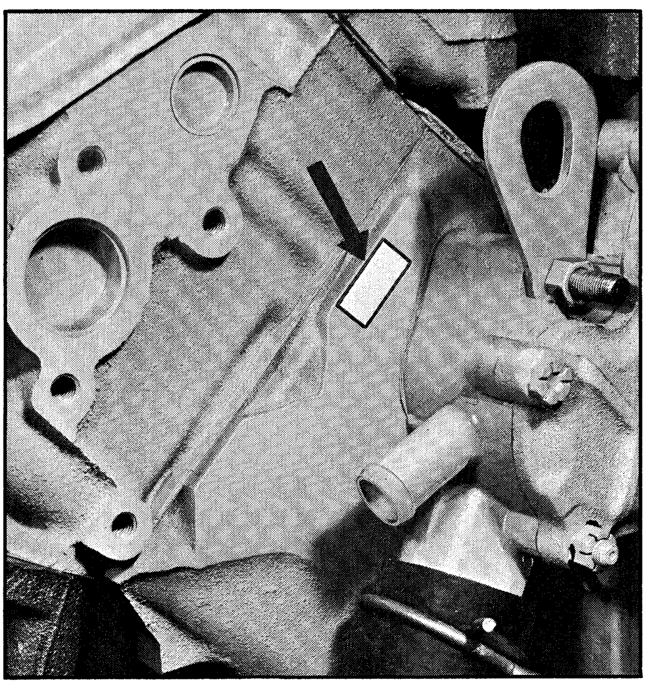


Fig. 6-91 Engine Number Location

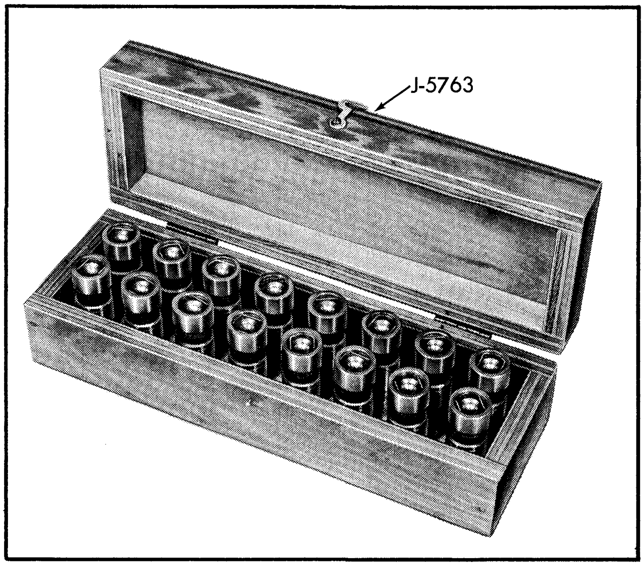



Fig. 6-92 Valve Lifter Storage Box

Since any dirt which may enter the oil galleries or passages in the engine could eventually get to a lifter, cleanliness should be exercised when any part of the engine is removed or disassembled. When a cylinder head is removed for any purpose, it is necessary to remove the push rod cover. This exposes the lifters to any dirt which may fall from the upper portion of the block or which may be carried in the air. Thus, it is wise to cover the lifter galleries until ready to reassemble the engine.

When lifters are removed for any reason, they should immediately be placed in order in valve lifter storage box J-5763 (Fig. 6-92). This is important for two reasons. First, it is the easiest way to keep

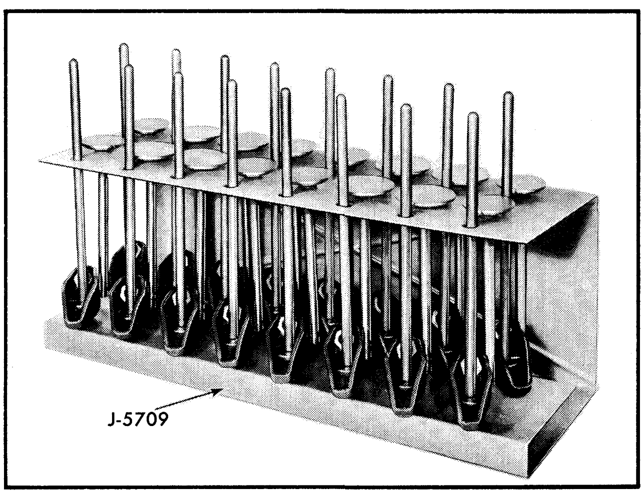



Fig. 6-93 Valve and Valve Train Holding Stand

lifters clean. Second, lifters should always be replaced in the same bosses from which they were removed.

Valves, valve lifters, push rods, rocker arms, rocker arm balls, and rocker arm ball nuts should always be kept in sets and returned to their original positions. These parts will tend to mate as the engine operates and will provide more satisfactory operation when kept together. By storing lifters in storage box J-5763 and valves, push rods, rocker arms, balls and nuts in holding stand J-5709 (Fig. 6-93) whenever they are removed, they can easily be kept in sets for identification during assembly. In addition to keeping the parts in sets, the push rods should be replaced with the same end up. In other words, the same end will contact the rocker arm as before the engine was disassembled. The upper end can usually be identified by the polished surface which contacts the rocker arm. Push rods will also be polished somewhat in the area where the rod passes through the head.

When hydraulic valve lifters are disassembled, the various parts of each lifter must be kept together. This is especially important since the lifter body and plunger are selectively fitted. The use of the special tray included with cleaning tank J-5821 will aid in keeping the parts of each lifter together when lifters are being serviced.

Cylinder head screws should be installed without thread sealer of any kind.

When raising or supporting the engine for any reason, do not use a jack under the oil pan or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump, jacking against the oil pan may cause it to be bent against the pump. The result would be a telegraphed noise which would be difficult to trace. The crankshaft pulley is sheet steel and will not support engine weight.

It should be kept in mind, while working on the engine, that the twelve volt electrical system is capable of violent and damaging short circuits. When performing any work where electrical terminals could possibly be grounded, the ground cable of the battery should be disconnected.

*CAUTION: Never reverse battery leads, even for an instant, as reverse polarity current flow will damage diodes in the generator.*

Any time the carburetor or air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material which could follow the intake passage in the cylinder and cause extensive damage when the engine is started.

In the mechanical procedures described in this section generally no references will be made to the removal of optional equipment such as power steering pump, air conditioning compressor, etc.

Should it become necessary to remove any such item to perform other service refer to the appropriate section of the manual for specific information.

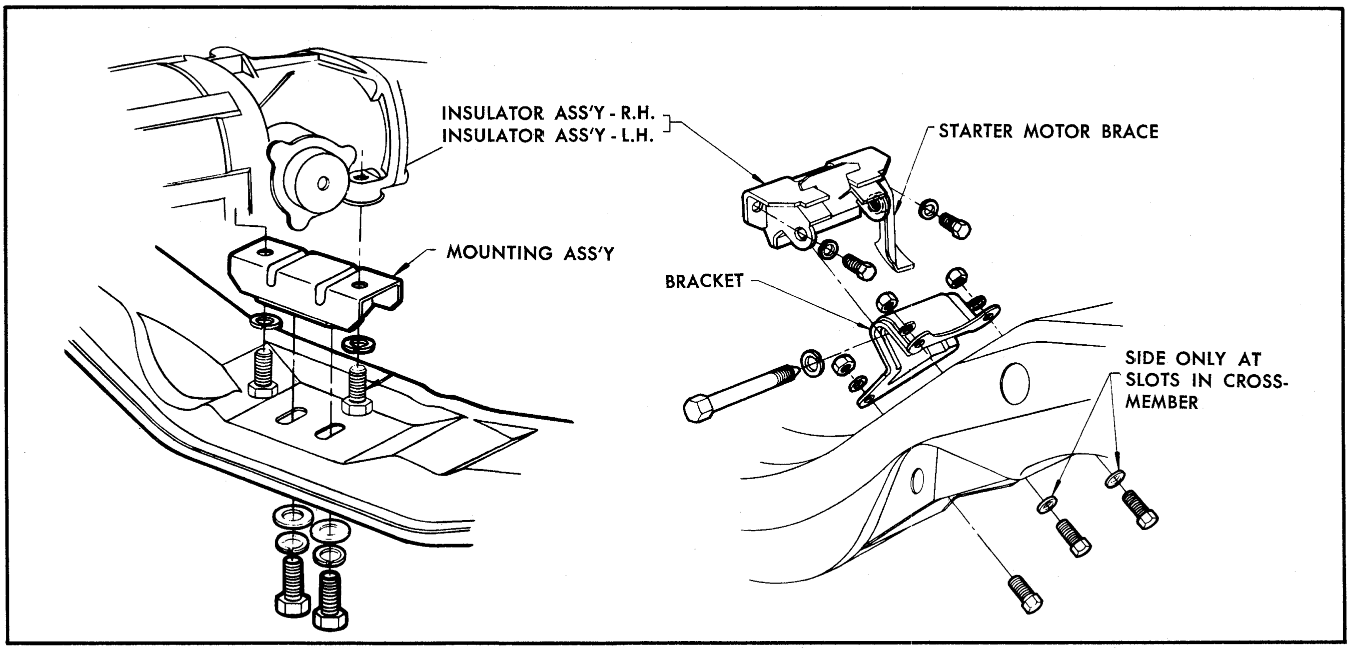



Fig. 6-94 Engine Insulators

### PERIODIC SERVICE

There are no periodic services required on the mechanical portions of the engine. Periodic services connected with the engine consist of tune-up, lubrication, replacing oil filter, etc. Procedures and recommendations for these services will be found in appropriate sections of this book.

## SERVICE OPERATIONS ON CAR

### ENGINE INSULATORS—REMOVE AND REPLACE (Fig. 6-94)

FRONT INSULATORS

1. Raise hood and, using suitable engine lifting equipment, take weight of engine off front insulators.

*NOTE: Disconnect battery ground strap before raising engine. When the engine is raised the starting motor solenoid terminals may contact the steering gear which could energize the starting motor if the ground cable is not disconnected.*

2. Loosen rear insulator by removing cross member to insulator bolts and raise rear of engine.

3. Remove bolts which fasten front insulators to frame bracket.

4. Raise engine just clear of insulators.

5. Remove insulator to engine bolts and remove insulators.

6. Position new insulators against engine and install attaching bolts and washers. Tighten to 40-55 lb. ft. torque.

7. Lower engine.

8. Install frame bracket to insulator bolts with lockwashers and tighten to 25-35 lb. ft. torque.

9. Lower rear of engine and transmission so that rear insulator positions on cross member. Install two cross members to insulator bolts and washers and tighten to 25-35 lb. ft. torque.

REAR INSULATOR

1. Remove two cross member to insulator bolts.

2. With suitable engine lifting equipment raise engine at rear to provide clearance for removing insulator to transmission housing bolts.

3. Remove two insulator to transmission bolts and remove insulator.

4. Install new insulator with two insulator to transmission housing bolts and washers and tighten to 25-35 lb. ft. torque.

5. Lower rear of engine and transmission so that insulator positions above cross member.

6. Install two cross members to insulator bolts with washers and tighten to 25-35 lb. ft. torque.

### ENGINE—REMOVE FROM VEHICLE

1. Drain coolant and engine oil.

2. Remove hood. SEE CHASSIS SHEET METAL CHECK.

3. Remove engine ground wire.

4. Remove air cleaner and disconnect throttle and transmission linkage.

5. On cars with power steering remove power steering pump belt and pump from mounting bracket, leaving hoses connected. Place pump in a position where it will not become damaged when engine is removed.

6. Remove upper and lower radiator hose and disconnect heater hoses from intake manifold and timing chain cover and remove from cylinder head clamp. On TempesTorque equipped cars remove inlet and outlet oil lines from radiator. Remove oil pressure warning light wire from switch terminal at filter. Remove automatic transmission cooler line clamps at front cross member.

7. Remove fuel pump inlet line.

8. Remove vacuum lines.

9. Remove terminal from thermogage unit on intake manifold, disconnect coil positive lead at coil, disconnect generator to regulator wires from generator, release from clip retaining to valve cover and pull clear of engine.

10. Remove battery ground from cylinder head and disconnect starter and solenoid at left fender skirt terminal. Open starter cable clip at front cross member and remove cable from clip.

11. Remove radiator and fan.

12. Loosen muffler and tail pipe supports, then disconnect exhaust pipe from each exhaust manifold. Wire exhaust pipe to engine rear support cross member.

13. Remove gear shift manual linkage at transmission.

14. Disconnect linkage from clutch release fork and remove clutch control countershaft bracket from flywheel housing (synchromesh equipped cars).

15. Remove speedometer cable at transmission.

16. Remove propeller shaft drive line assembly and insert splined plug on transmission output shaft.

17. With chain and overhead hoist raise engine and transmission assembly slightly to remove weight from engine insulators. Disconnect insulators from frame.

18. Remove engine and transmission as an assembly by lifting forward and upward.

### ENGINE—INSTALL IN VEHICLE

1. Assemble clutch and transmission to engine.

2. Install rear insulator on transmission extension and install front insulators to engine. Tighten rear insulator to transmission extension bolts 25-35 lb. ft. and front insulators to engine bolts 40-55 lb. ft.

3. Using suitable engine lifting equipment, carefully lower engine, clutch (SM) and transmission assembly into position in vehicle. Fasten front insulators to frame bracket with thru bolts and tighten nuts to 25-35 lb. ft. Fasten rear insulator to cross member and tighten bolts to 25-35 lb. ft.

4. Install propeller shaft.

5. On synchromesh models, connect clutch linkage. See Engine Clutch Section.

6. Connect gearshift manual linkage to transmission.

7. Connect exhaust pipe assembly to exhaust manifolds.

8. Install starter and solenoid leads to left fender skirt terminal.

9. Install starter cable in clip and install clip to front cross member.

10. Install radiator.

11. Connect regulator to generator wires, routing through clips along right rocker arm cover. Connect coil positive lead and connect leads to thermogauge terminal.

12. Connect power brake vacuum hose to check valve to carburetor pipe, if car is so equipped.

13. Connect fuel inlet line to fuel pump and connect oil pressure sending unit lead.

14. Connect upper and lower radiator hoses and heater hoses. Install heater hoses in cylinder head clamp.

15. On cars equipped with automatic transmission, install cooler line clamps to front cross member and connect lines to radiator.

16. Install vacuum line to carburetor.

17. Install power steering pump and belt and adjust belt tension if car is so equipped.

18. Connect throttle linkage and install carburetor air cleaner.

19. Install battery cable and connect battery cables to posts.

*CAUTION: Never reverse battery leads even for an instant, as reverse polarity current flow will damage diodes in generator.*

20. Install ground wire.

21. Install hood.

22. Fill cooling system and crankcase.

23. Adjust ignition timing, carburetor and transmission linkage if necessary.

## MANIFOLDS—VALVE TRAINS—CYLINDER HEADS

### *RIGHT SIDE EXHAUST MANIFOLD OR GASKET—REMOVE AND REPLACE*

REMOVE

1. Disconnect exhaust pipe from manifold.

2. Straighten tabs on manifold front and rear individual bolt locks and remove manifold attaching bolts, manifold, and gasket.

*NOTE: Locks are used on the front and rear pairs of bolts only.*

REPLACE

1. Thoroughly clean gasket surfaces of cylinder head and exhaust manifold. Check condition of heat control valve and related parts.

2. Replace exhaust manifold and new gasket. Use new individual manifold bolt locks on front and rear pairs of bolts.

*NOTE: Place manifold outlet in position over end of exhaust pipe but do not permit weight of manifold to rest on exhaust pipe. Since the end holes of the gasket are slotted, installation of gasket may be simplified by first installing the manifold using only the front and rear bolts to retain manifold. Allow clearance of about 3/16" between cylinder head and exhaust manifold. After inserting the gasket between head and manifold, the remaining bolts may be installed.*

3. Tighten all bolts evenly and securely to 20-35 lb. ft. torque. Bend tab of screw locks against bolt heads.

*NOTE: Be sure tabs are bent against sides of bolt heads, not on top of bolt heads.*

4. Attach exhaust pipe to manifold with bolts and tighten to 25-35 lb. ft.

### *LEFT SIDE EXHAUST MANIFOLD OR GASKET—REMOVE AND REPLACE*

REMOVE

1. Remove generator belt and remove generator and mounting bracket as an assembly.

2. Disconnect exhaust pipe from manifold.

3. Straighten tabs on manifold individual bolt locks. (Tabs can be straightened from beneath car by using long handled screwdriver.)

*NOTE: Locks are used on front and rear pairs of bolts only.*

4. Remove manifold attaching bolts and remove manifold.

REPLACE

1. Thoroughly clean gasket surfaces of cylinder head and exhaust manifold.

2. Place manifold in position against cylinder head and install two end bolts, finger tight.

3. Slide gasket between manifold and cylinder head.

4. Install remaining bolts and new bolt locks.

5. Tighten all bolts evenly and securely to 20-35 lb. ft. torque. Bend tabs of bolt lock against bolt heads.

6. Attach exhaust pipe to manifold and tighten to 25-35 lb. ft. torque.

### *INTAKE MANIFOLD OR GASKET—REMOVE AND REPLACE*

REMOVE

1. Drain water from radiator and from each side of cylinder block.

*NOTE: Most of the water can be drained from the block through the radiator drain by raising rear end of car approximately 15 to 18 inches off the floor.*

2. Remove air cleaner.

3. Remove upper radiator hose.

*NOTE: If condition of hose does not warrant replacing with new hose, possible damage to hose and clamps can be reduced by leaving hose attached to water outlet. In this case water outlet may be disconnected from manifold and moved out of way.*

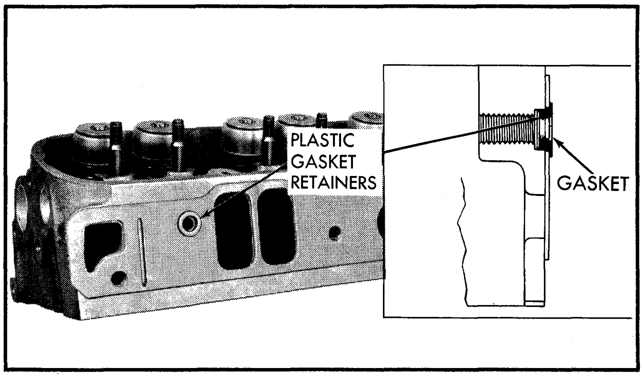



Fig. 6-95 Installing Intake Manifold Gasket

4. Disconnect heater hose from fitting.

5. Disconnect wire from thermogauge unit.

6. Remove two spark plug wire brackets from manifold.

7. On cars equipped with power brakes, remove power brake vacuum pipe from carburetor.

8. Disconnect distributor to carburetor vacuum hose.

9. Disconnect fuel line connecting carburetor and fuel pump.

10. Disconnect crankcase vent hose from intake manifold.

11. Disconnect throttle rod from carburetor.

12. Remove screws retaining throttle control bracket assembly.

13. Remove intake manifold retaining bolts and nuts, and remove manifold and gaskets.

*NOTE: Make certain "O" ring seal between intake manifold and timing chain cover is retained and installed during assembly if not damaged.*

REPLACE

*NOTE: When a new manifold is to be installed, transfer carburetor, water outlet, thermostat, heater hose fitting and thermogauge fitting. Use new gaskets on those units requiring gaskets and new "O" ring seal between manifold and timing chain cover.*

1. Install new gaskets on cylinder heads, positioning them with plastic retainers (Fig. 6-95).

2. Install intake manifold on engine.

3. Install "O" ring seal.

4. Install cap bolts and nuts loosely.

5. Position throttle control bracket assembly on manifold and install cap bolts.

6. Tighten timing chain cover to intake manifold bolt until both units are metal to metal (10-20 lb. ft. torque).

7. Tighten all nuts and bolts evenly to 40-45 lb. ft. torque.

8. Connect throttle rod to carburetor.

9. On cars equipped with power brakes, install vacuum pipe to carburetor.

10. Install fuel pipe connecting carburetor to fuel pump.

11. Install crankcase vent hose to intake manifold fitting.

12. Connect heater hose to fitting.

13. Install upper radiator hose.

14. Connect wire to thermogauge unit terminal.

15. Install vacuum hose connecting distributor vacuum advance unit to carburetor.

16. Install spark plug wire bracket.

17. Replace air cleaner.

18. Close drain plug and fill radiator to proper level.

19. Check automatic transmission linkage adjustments.

***PUSH ROD COVER OR GASKET—
REMOVE AND REPLACE***

REMOVE

1. Remove intake manifold, retaining "O" ring seal.

2. Remove crankcase ventilator hose.

3. Remove screws from push rod cover and remove cover.

REPLACE

1. Cement new gasket on push rod cover.

2. Replace push rod cover and tighten screws to 5 lb. ft. torque.

3. Replace positive crankcase ventilation hose.

4. Install intake manifold and "O" ring seal.

### *VALVE SPRINGS, SHIELD OR SEAL—REMOVE AND REPLACE*

REMOVE

1. Remove rocker arm cover, spark plug and distributor cap. (Remove rear generator bracket on right side.)

2. Remove rocker arm.

3. After removing rocker arm, thread valve spring compressor stud J-8929-1 on rocker arm stud and compress valve spring using compressor J-6384-1

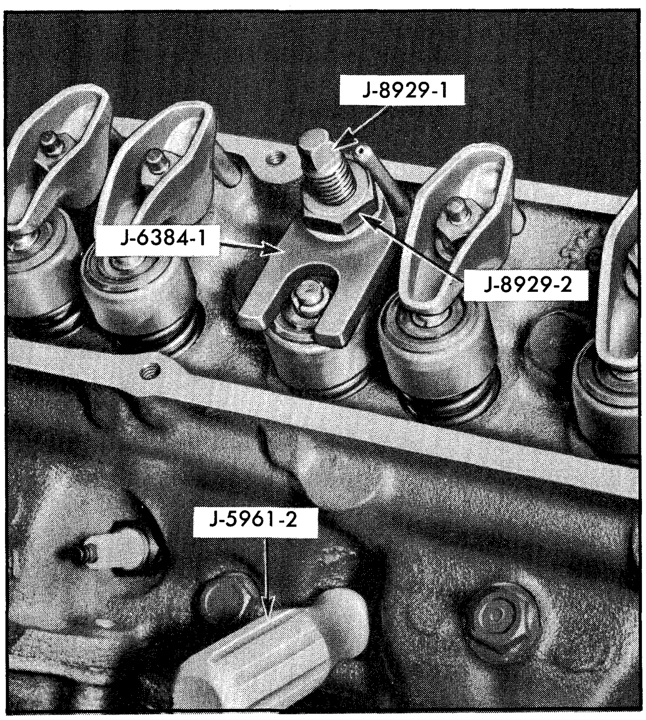



Fig. 6-96 Valve Spring Compressed

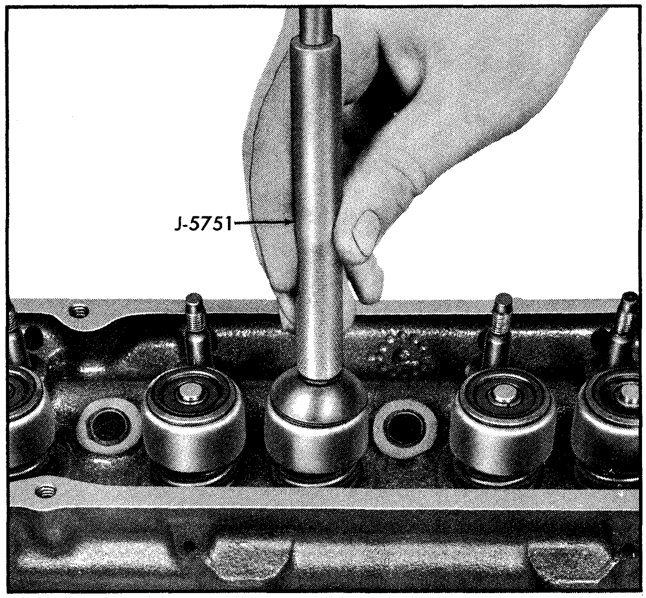



Fig. 6-97 Checking Valve Stem Seal

and nut J-8929-2 while holding valve up with valve holder J-5961-2 (Fig. 6-96). Remove valve spring retainer cup locks and then remove valve spring compressor, valve spring retainer cup shield and valve stem seal.

REPLACE

1. Install new part or parts, compress springs with valve spring compressor J-6384-1 and nut J-8929-2 (while holding valve up with holder J-5961-2), install valve stem seal and retainer cup locks. Remove spring compressor and valve holder, then test valve stem seal using suction cup end of tool J-5751 (Fig. 6-97).

2. Install rocker arm, tighten rocker arm ball retaining nut to 15-25 lb. ft. torque.

3. Replace rocker arm cover, spark plug, distributor cap and connect spark plug wire.

### *PUSH ROD AND VALVE LIFTER—REMOVE AND REPLACE*

REMOVE

1. Remove intake manifold, retaining "O" ring seal.

2. Remove push rod cover.

3. Remove rocker arm cover.

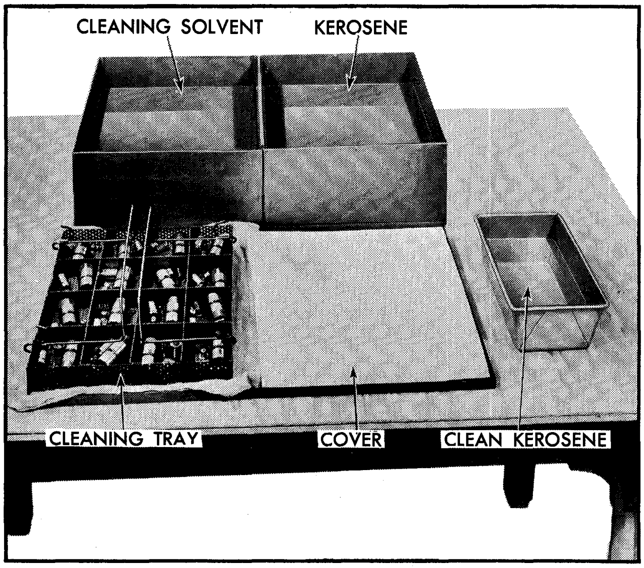



Fig. 6-98 Lifter Wash Tank and Tray J-5821

4. Loosen rocker arm ball nut and move rocker arm off push rod.

5. Remove push rod.

6. Before removing standard lifter that is suspected of having a stuck plunger, it can be tested using lifter plunger unloader J-5097. To check lifter, insert pin of unloader tool through hole in push rod seat and push down on tool. Pin will unseat ball, and tool will move push rod seat and plunger down. If lifter plunger is stuck, it will be impossible to move push rod seat down.

*NOTE: In order to unseat the ball in special 326 H.O. Synchromesh lifters it is necessary to remove the retaining clip, push rod seat and orifice plate before using plunger unloader J-5097.*

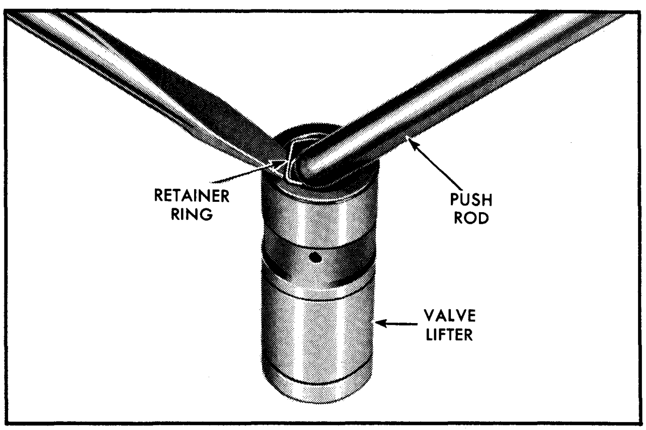



Fig. 6-99 Removing Push Rod Seat Retainer Ring

7. Remove lifter. Hydraulic valve lifter remover J-3049 may facilitate removal of lifter.

*NOTE: If more than one lifter is to be replaced, store push rods in stand J-5709 and lifters in lifter box J-5763 so they can be re-installed in exactly the same place and position. See GENERAL INFORMATION ON ENGINE SERVICE.*

REPLACE

*NOTE: If new lifter is to be installed, be sure to remove all sealer coating from inside of new lifter and check leakdown rate. See page*

1. Place new lifter in lifter boss.

2. Replace push rod exactly as removed (same end against rocker arm).

3. Position rocker arm on push rod and tighten rocker arm ball retaining nut to 15-25 lb. ft. torque.

4. Replace rocker arm cover.

5. Inspect condition of push rod cover gasket and replace if necessary; replace push rod cover and tighten screws to 2-6 lb. ft. torque.

6. Replace intake manifold using new gaskets and replace "O" ring seal.

VALVE LIFTER - RECONDITION

*NOTE: Because of the important part hydraulic valve lifters play in the operation of an engine and the close tolerances to which they are manufactured, proper handling, and above all, cleanliness, cannot be overstressed when servicing these parts.*

New lifters are serviced as individual units packaged with a plastic coating. Leaving the coating on until ready to check leakdown rate. It is not necessary to remove the oil from new lifters prior to checking leakdown rate since special leakdown oil is already in new lifters.

Wash tank and tray J-5821 (Fig. 6-98) is recommended for cleaning valve lifters. This tank should be used only for valve lifters and should be kept covered when not in use. All servicing should be done in an area removed from grinders or other sources of dust and foreign material.

Lifters should at all times be stored in a covered box (Fig. 6-92) which will aid in keeping them clean. The lifter box should be kept dry and as free of oil as possible.

VALVE LIFTER - DISASSEMBLE

1. Remove push rod seat retainer ring by holding seat down with push rod while dislodging spring from lifter body with a pointed tool (Fig. 6-99).

*NOTE: It may be necessary to unseat lifter ball, using plunger unloader J-5097, before plunger can be pushed down.*

2. Invert lifter and allow push rod seat and plunger to slide out of body. If plunger sticks in body, place lifter in large end of hydraulic valve lifter plunger remover J-4160-A, with push rod end of lifter downward. Hold tool firmly in hand with thumb over lifter body and sharply strike the tool against a block of wood (Fig. 6-100) until plunger falls out.

*NOTE: It may be necessary to soak a lifter having a stuck plunger in cleaning solvent for several minutes in order to remove the plunger.*

3. Drain oil out of lifter body and place all valve lifter parts in separate compartment of tray from wash tank J-5821 (Fig. 6-98).

*CAUTION: Valve lifter body and plunger are selectively fitted and must not be interchanged with parts of other lifters. (Keeping all parts of lifters together will also aid in trouble diagnosis.)*

VALVE LIFTER - CLEAN AND INSPECT

Wash tank J-5821 is recommended for cleaning valve lifter parts. This tank consists of two chambers, a tray and a cover. One chamber is for cleaning solvent and the other is for kerosene. Whenever the tank is not being used (and when parts are soaking), the cover should be closed.

1. Before placing tray of parts in cleaning solvent, first immerse it in kerosene chamber to remove as much engine oil as possible. (This reduces contamination of solvent, thus prolonging its useful life.)

2. Submerge tray in cleaning solvent and allow to soak for approximately one hour. More time may be required depending on varnish condition and effectiveness of solvent. Light agitation of tray in solvent at 10-15 minute intervals will hasten cleaning action.

3. After varnish has dissolved or has been sufficiently softened to permit removal by wiping, suspend tray above solvent, utilizing hooks on tray handles. Allow tray and parts to drain for a brief period.

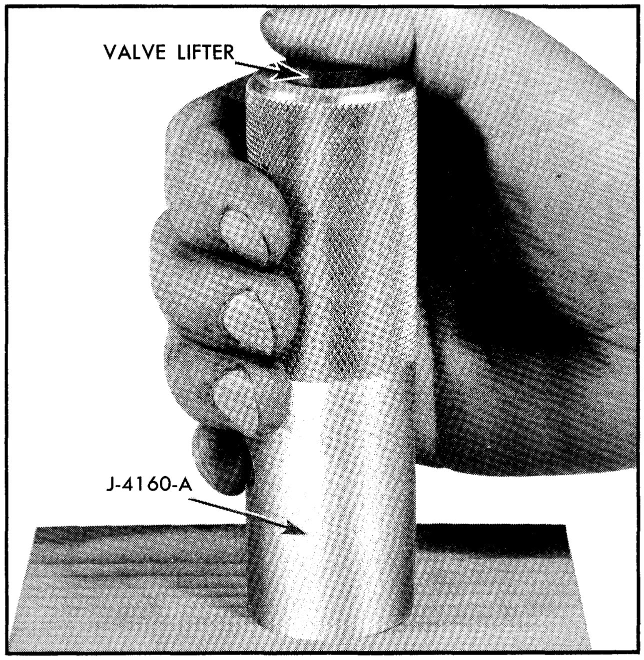



Fig. 6-100 Removing Stuck Plunger With J-4160-A

4. Rinse tray of parts in kerosene chamber to cut solvent and to avoid injury to hands (from solvent).

5. Wipe out tank cover and place tray of parts on cover in front of tank (Fig. 6-98). A shop towel under tray and clean paper on remainder of cover will enhance cleanliness.

*NOTE: Absolute cleanliness can be assured if each lifter is inspected and assembled after cleaning before proceeding to the next lifter.*

6. Working on one lifter at a time and using clean, lint-free cloths, thoroughly wipe off lifter parts. Clean plunger and external and internal surfaces of body with a hard wiping action. A bristle brush may be used to clean internal surface of lifter body.

*CAUTION: Do not use wire brush or sand paper, since damage to machined surface is likely.*

7. Inspect lifter body. Both inner and outer surfaces of lifter body should be inspected for scoring. Lifter assembly should be replaced if body is roughly scored, grooved, or galled. Inspect cam contact surface on lower end of lifter body. Replace the lifter assembly if this surface is excessively worn, galled or otherwise damaged.

8. Inspect lifter plunger. Using a magnifying glass, inspect the check ball seat for defects. Inspect outer surface of plunger for scratches or scores. Small score marks with a rough, satiny finish will cause

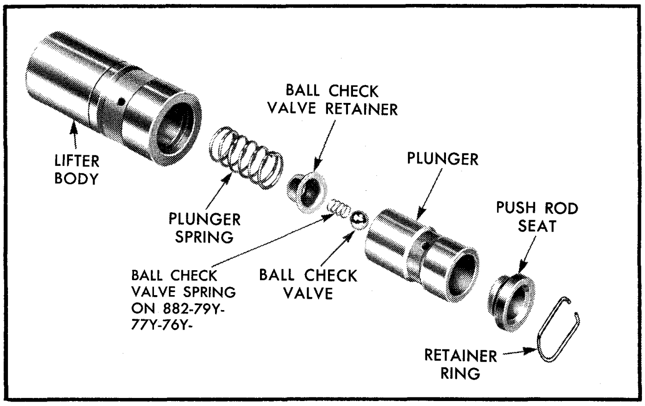



Fig. 6-101 Exploded View - Valve Lifter

the plunger to seize when hot but operate normally when cool. Defects in check ball seat or scores or scratches on outer surface of plunger which may be felt with a fingernail are causes for replacing the lifter assembly. This rule does not apply to the slight edge which may sometimes be present where the lower end of plunger extends below the ground inner surface of the body. This edge is not detrimental unless it is sharp or burred.

A blackened appearance is not a malfunctioning condition. Sometimes the discoloration serves to highlight slight grinder chatter marks and give the outer surface of plunger a ridged or fluted appearance. This condition will not cause improper operation, therefore, it may be disregarded.

9. Inspect push rod seat. Inspect push rod seat for roughness and make sure that hole in center is open.

10. Inspect valve lifter ball. Carefully examine ball for nicks, imbedded material or other defects

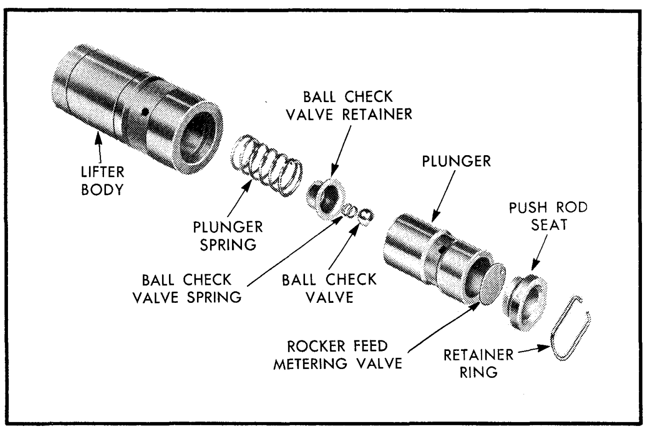



Fig. 6-102 Exploded View - 326 H.O. with Synchromesh Valve Lifter

which would prevent proper seating. Such defects may cause intermittently noisy lifter operation. Also inspect plunger face of ball retainer for excessive wear.

VALVE LIFTER - ASSEMBLE

*NOTE: All parts must be absolutely clean when assembling a hydraulic lifter. Since lint and dust may adhere to parts they should not be blown off with air or wiped with cloths. All parts should be rinsed in clean kerosene and assembled without drying. A small container with clean kerosene (separate from cleaning tank) should be used for each set of lifters being overhauled.*

Figures 6-101 and 6-102 show the relative position of component parts of valve lifters. The recommended procedure for assembly is given in the following steps.

1. Rinse plunger spring and ball retainer and position retainer in spring.

2. Rinse lifter ball and place in retainer.

3. Rinse plunger and place on retainer so that seat on plunger mates with ball.

4. Invert plunger with parts assembled thus far and, after rinsing lifter body, install body over spring and plunger.

Fig. 6-103 Testing Leak-Down Rate

5. Place orifice feed plate in plunger (326 H.O. SM).

6. Place lifter body on clean paper; rinse and install push rod seat and retainer ring.

7. After lifter has been assembled, place in lifter box and close lid to preserve cleanliness.

TEST VALVE LIFTER LEAKDOWN RATE

After all lifters have been assembled, the leakdown rate must be checked before they are installed in the engine. Valve lifter leakdown tester J-5790 (Fig. 6-103) is designed to test leakdown rate of lifters to determine whether or not they are within specified limits. As with previous service operations concerned with lifters, cleanliness is important. The tester cup and ram should be thoroughly cleaned, and testing should be done in an area free of dust and dirt. The testing procedure is described in the following steps:

1. Fill tester cup to approximately one inch from top with special fluid which is available from your lifter tester dealer.

*NOTE: No other type fluid is recommended.*

2. Swing weight arm up out of the way, raise ram, and position lifter into boss in center of tester cup.

3. Adjust ram (with weight arm clear of ram) so that the pointer is positioned on the set line (marked "S"). Tighten jam nut to maintain setting.

4. Operate lifter through full travel of plunger by pumping weight arm to fill lifter with test fluid and force out air. (Lifter must be completely submerged at all times.) Continue pumping for several strokes after definite resistance is detected.

5. Raise weight arm to allow plunger spring to expand fully; lower arm onto ram and commence turning crank slowly (1 revolution every 2 seconds). Time indicator travel from lower line (first line above set line) to line marked .125 or 1/8", while still rotating cup with crank (Fig. 6-103). Lifter is satisfactory if rate is between 12 and 60 seconds.

A doubtful lifter should be tested three or four times. Disassemble, inspect, and re-test doubtful lifters. If leakdown still is not within specifications, replace lifter.

6. After each lifter is tested, replace in lifter box to ensure cleanliness. Leave lifters in box until ready for installation in cylinder block.

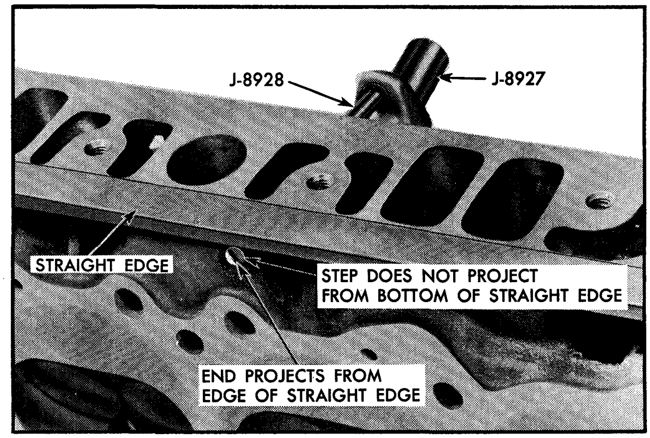



Fig. 6-104 Position of Gauge J-8928 When Stud is Properly Installed

7. When all lifters have been tested, empty cup, clean, and place cover over tester to maintain its cleanliness.

### *CYLINDER HEAD OR GASKET— REMOVE AND REPLACE*

REMOVE

1. Remove intake manifold, push rod cover, and rocker arm cover.

2. Loosen all rocker arm retaining nuts and move rocker arms off push rods.

3. Remove push rods and place in support stand J-5709 so they can be replaced in exact position from which they were removed. See GENERAL INFORMATION ON ENGINE SERVICE.

4. Remove exhaust crossover pipe to manifold attaching bolts.

5. Remove battery ground strap and engine ground strap on left head or engine ground strap and Hydra-Matic oil level indicator tube bracket on right head.

6. Remove cylinder head bolts (dowel pins will hold head in place) and remove head with exhaust manifold attached using lifting hooks J-4266.

*CAUTION: Extreme care should be taken when handling or storing cylinder heads as the rocker arm studs are hardened and may crack if struck.*

*NOTE: If left head is being removed, it will be necessary to raise head off dowel pins, move it forward, and "jockey" the head in order to clear the power steering and power brake equipment if car is so equipped.*

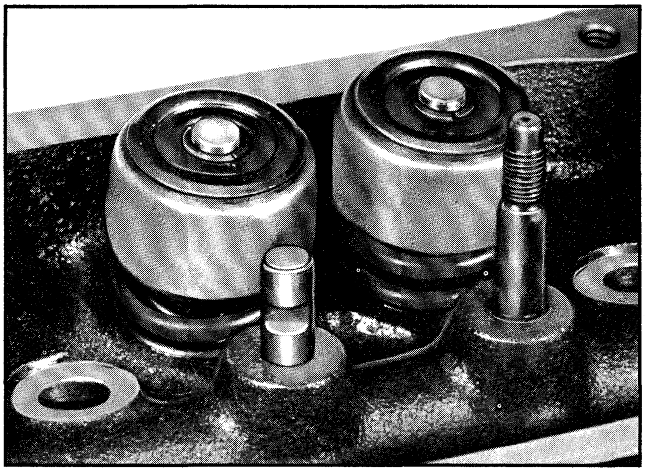


Fig. 6-105 Slots Filed in Rocker Arm Stud

7. Remove cylinder head gasket.

REPLACE

*NOTE: Right and left cylinder heads are the same. New heads are complete with rocker arm studs, and all plugs.*

When installing new head, transfer all serviceable parts to new head using new seals on intake and exhaust manifold valve stems, and new exhaust manifold gasket. Install new intake manifold gasket plastic retainers. Clamp straight edge into position as shown in Fig. 6-104 and check rocker arm position with valve train gauge J-8928.

1. Remove straight edge from cylinder head and thoroughly clean gasket surfaces of head and block. Place new gasket on block, and replace cylinder head.

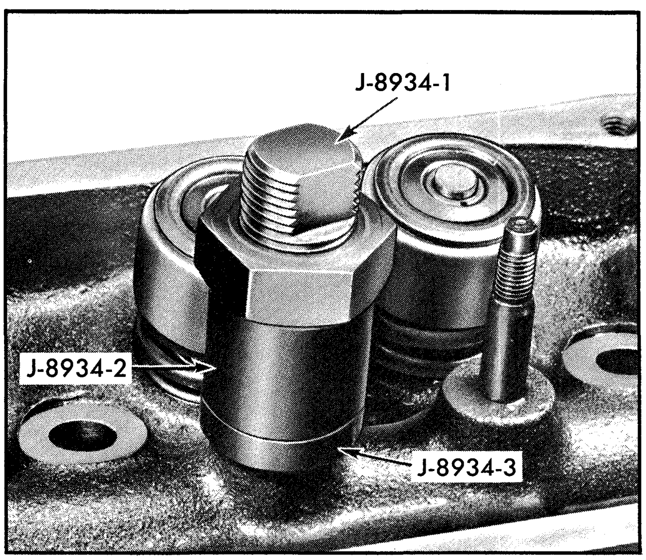



Fig. 6-106 Tool J-8934 Positioned to Remove Rocker Arm Stud

2. Start all bolts in threads.

*NOTE: Bolts are three different lengths. When inserted in proper holes all bolts will project an equal distance from head. Do not use sealer of any kind on threads.*

3. Tighten bolts evenly to 85-100 lb. ft. torque.

4. Install push rods in same location from which they were removed and with the same end up against rocker arm.

5. Reposition rocker arms and tighten rocker arm ball retaining nuts to 15-25 lb. ft. torque.

6. Replace rocker arm cover and tighten screws to 5 lb. ft. torque.

7. Replace push rod cover and tighten screws to 5 lb. ft. torque.

8. Replace battery ground strap and engine ground strap on left head or engine ground strap and automatic transmission oil level indicator tube bracket on right head. Also, replace the engine oil level indicator on right side.

9. Replace intake manifold using new gaskets.

**ROCKER ARM STUDS—REMOVE AND REPLACE**

(Rocker arm studs are replaceable providing a press of two tons capacity or more is available.)

*NOTE: Both standard and .003" oversize studs are available. If stud has become loose, replace with .003" oversize stud and install according to steps 7 through 19. If replacing stud that is broken or because of faulty threads or oil hole, use standard size stud and install according to steps 8 through 19.*

1. Remove cylinder head from engine.

2. With rocker arm removed, file two slots 3/32" to 1/8" deep on opposite sides of rocker arm stud (Fig. 6-105). Top of slots should be 1/4" to 3/8" below thread travel.

3. Place washer at bottom of rocker arm stud.

4. Position rocker arm stud remover J-8934 on rocker arm stud and tighten screws securely with 5/32" allen wrench.

5. Place spacer over stud remover J-8934.

6. Thread 7/8" standard nut on stud remover and turn nut until rocker arm stud is out of cylinder head (Fig. 6-106).

7. Remove plugs (Fig. 6-105) from ends of cylinder head oil gallery and thoroughly clean out metal deposits and foreign matter from oil gallery (head must be right side up so foreign material will not lodge in or around studs).

8. Position rocker arm on new rocker arm stud and place rocker arm stud installer J-8927 on stud in place of rocker arm ball.

9. Coat rocker arm stud with white lead and oil and with cylinder head mounted in press on tool J-5712, so studs are vertical, position new stud with rocker arm and rocker arm stud installer over hole in head (Fig. 6-109).

10. Carefully press stud into head until it is in about half way (7/16").

11. Clamp straight edge on cylinder head as shown in Fig. 6-109 and position valve train gauge J-8928 in push rod hole so that it seats properly in the rocker arm.

12. With valve seated, slowly press rocker arm stud into cylinder head (Fig. 6-106) until gauge projects about midway between the end of the gauge and the step with respect to the straight edge as shown in Fig. 6-104.

13. Remove rocker arm stud installer J-8927, rocker arm and ball and straight edge.

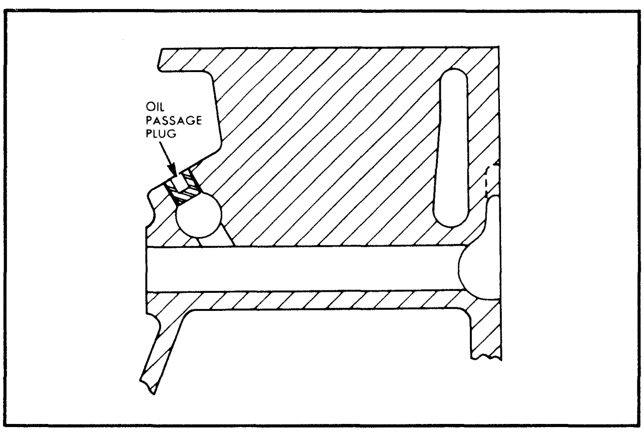



Fig. 6-107 Cylinder Head Oil Passage Plug

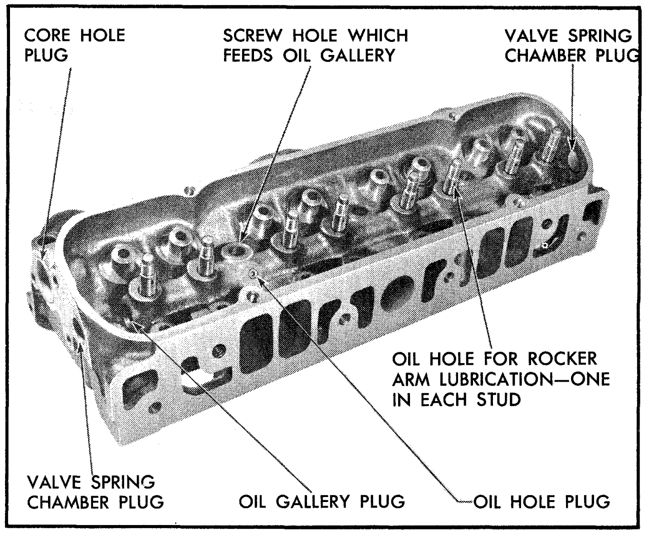



Fig. 6-108 Cylinder Head Passage Identification

14. Blow air through hole in new stud to ensure that the passage is not restricted.

15. Blow air through oil gallery to remove any foreign matter.

16. Replace plugs in ends of oil gallery (Fig. 6-107).

17. Check oil passages from oil gallery to all studs. See CYLINDER HEAD AND VALVES - CLEAN AND INSPECT.

18. Install rocker arm and ball and install nut loosely.

19. Replace cylinder head.

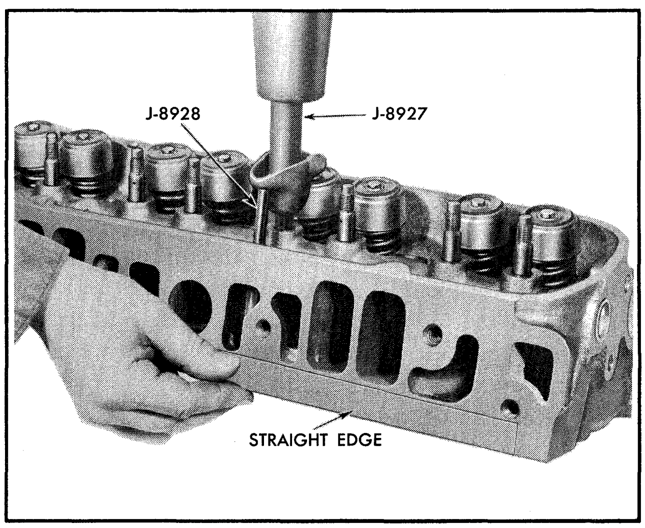



Fig. 6-109 Pressing in New Rocker Arm Stud

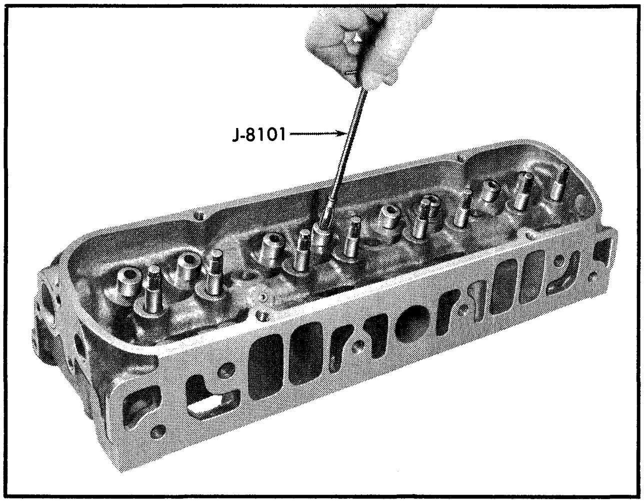



Fig. 6-110 Cleaning Valve Guide With J-8101

## CYLINDER HEAD AND VALVES—RECONDITION

CYLINDER HEAD AND VALVES

DISASSEMBLE

1. Remove valve spring retainer cup locks (keepers), valve stem oil seals, valve spring retainer cups, valve stem shields, valve springs, and valves, using valve spring compressor J-8929. Valve stem oil seals must be discarded and replaced with new seals any time they are removed.

2. Place valves in valve and valve train holding stand J-5709.

CYLINDER HEAD AND VALVES - CLEAN AND INSPECT

Efficient engine performance depends to a great degree upon the condition of engine valves. Close inspection of intake valves is especially important as excessive clearance of valve stems in guides will permit oil to be pulled into the combustion chamber causing fouled spark plugs and clogged piston rings. Oil deposited on valve heads will carbonize and burn causing valves to leak with resultant loss of engine power. Therefore, valves must operate properly and if inspection discloses any malfunction of valves, the trouble must be corrected to avoid future damage to valves or related engine parts.

1. Inspect valves and seats to determine condition before cleaning. Also check oil and water passage plugs for evidence of leakage (Fig. 6-107).

2. Clean valves thoroughly to remove deposits from head and stem.

3. Clean and inspect cylinder head as follows:

a. Clean carbon deposits from combustion chambers and all sludge or foreign matter from other areas of cylinder head. If a scraper or wire brush is used for cleaning, use care to prevent damage to valve seats.

*CAUTION: To prevent damage to valve seat it is good practice to keep wire brush well away from seat.*

b. Clean cylinder head thoroughly using suitable cleaning equipment.

c. Check oil passages from oil gallery through rocker arm studs. A simple test can be made using a rubber hose and smoke. Block lower end of cylinder head screw hole which feeds oil gallery (Fig. 6.107) and blow smoke in top end of hole through rubber hose. Smoke should come out hole in each stud.

4. Clean valve guides thoroughly using valve guide cleaner J-8101 (Fig. 6-110).

5. Visually inspect valve guides for evidence of wear, especially the end toward the spring seat. If a guide is scored or galled, install valve with proper oversize stem according to procedure on page 6-

6. Clean valve springs and inspect to see that they meet specifications.

7. Clean push rods and thoroughly clean out oil passage through center of rod. Inspect to see that the rod is straight.

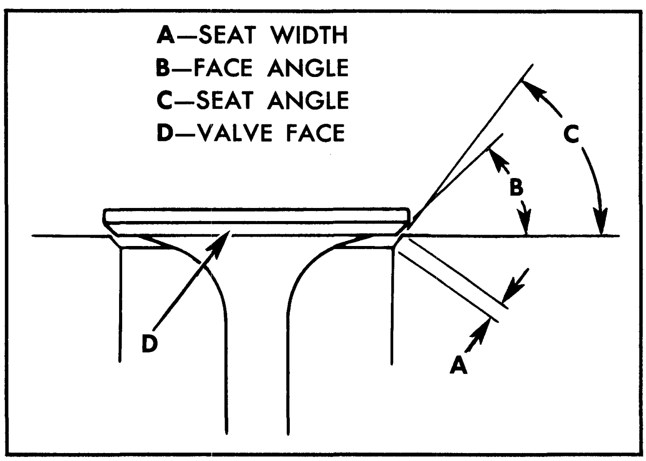



Fig. 6-111 Valve Seat and Face Angles

8. Clean rocker arms and rocker arm balls, and visually inspect for evidence of wear.

9. Clean spark plugs as outlined in ELECTRICAL SECTION.

10. Clean and inspect valve lifters.

VALVES AND SEATS - RECONDITION

1. Reface valves and seats as follows:

Valves should be ground on a special bench grinder designed specifically for this purpose and built by a reputable manufacturer. Valve seats should be ground with reputable power grinding equipment having stones of the correct seat angle and a suitable pilot which pilots in the valve stem guide. To ensure positive sealing of the valve face to its seat, the grinding stones should be carefully refaced before any grinding is done. Intake valve seat angle is 30°, exhaust valve seat angle is 45°. Intake valve face angle is 29° and exhaust valve face angle is 44°. This will provide hairline contact between valve and seat to provide positive sealing and reduce build-up of deposits on seating surfaces (Fig. 6-111).

DO NOT USE REFACING EQUIPMENT EXCESSIVELY; only enough material should be removed to true up surfaces and remove pits. The valve head will run hotter as its thickness is diminished; therefore, if valve face cannot be cleaned up without grinding to point where outside diameter of valve has a sharp edge, the valve should be replaced. Whenever it is necessary to replace a valve, the new valve should be of the same stem diameter as the valve removed (unless the valve guide is reamed to provide proper fit).

Width of exhaust valve seats should be 1/16" (.048"-.070). Intake valve seat should be between

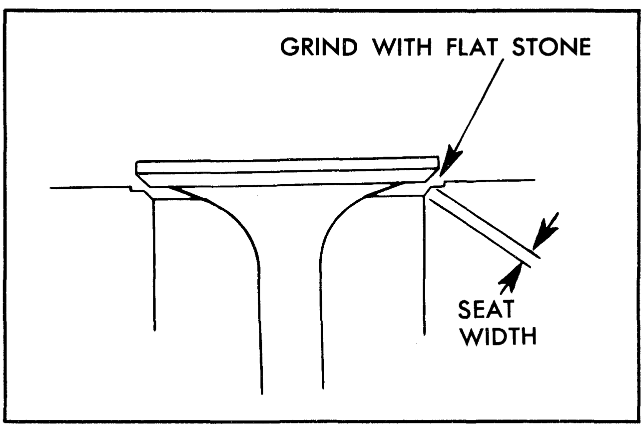



Fig. 6-112 Valve Seat After Grinding With Flat Stone

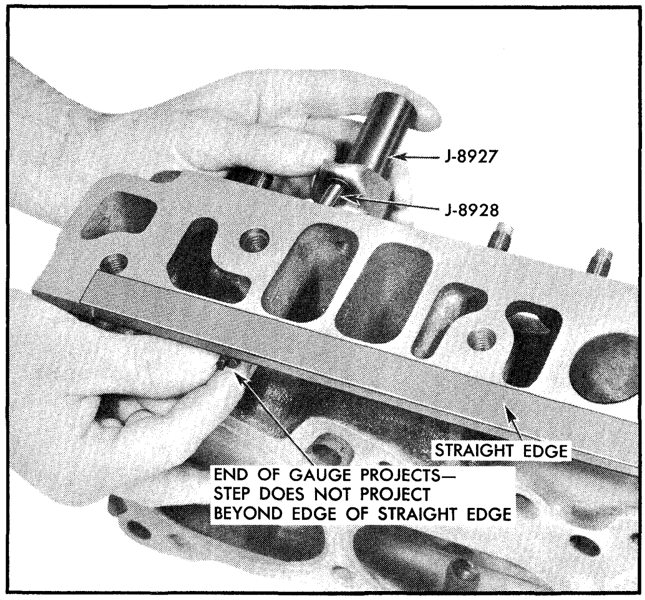



Fig. 6-113 Checking Length of Valve Stem with J-8928

3/64" and 1/16" (.045"-.071"). If seat width is excessive it should be narrowed by grinding with a flat stone (Fig. 6-112). This is the only method that should be used to narrow the seat.

*NOTE: Lapping of valve seats is not required or recommended.*

2. Check concentricity of valve seat and valve guide. Concentricity of valve seat and valve guide can be checked by using a suitable dial indicator or prussion blue. When using a dial indicator, total runout should not exceed .002".

When prussian blue is used, a light coat should be applied to the face of the valve only and the valve rotated in its seat. If blue appears all the way around the valve seat, the valve seat and the valve guide are concentric with one another.

3. Check concentricity of valve stem and face of valve. After cleaning prussian blue from valve and seat, lightly coat valve seat again with prussian blue and rotate valve in guide. If blue appears all the way around the valve, the valve stem and valve face are concentric with one another.

*NOTE: Both tests in steps 2 and 3 are necessary to insure proper valve seating.*

4. Check and correct length of valve stem using valve train gauge J-8928 as follows:

a. Position rocker arm on stud and hold in place using rocker arm stud installer J-8927. Slip

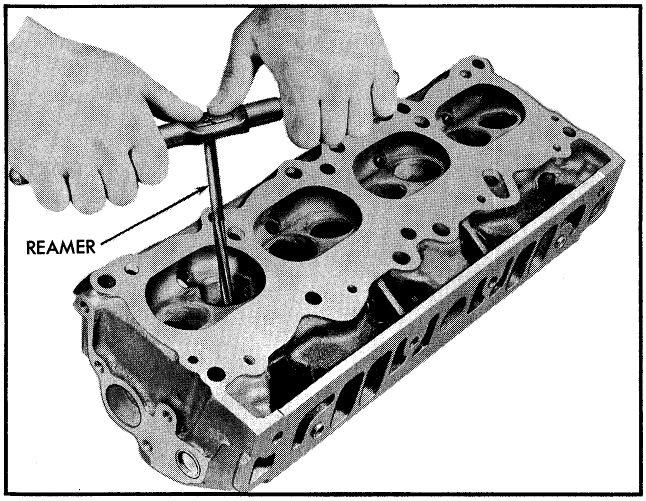



Fig. 6-114 Fitting Valve Stem to Guide

valve into place and hold it against valve seat. While holding rocker arm and valve in position securely, insert valve train gauge J-8928 through push rod hole and seat snugly in push rod seat of rocker arm (Fig. 6-113). With all parts seated, step end of gauge should be at least flush with gasket face of head, but should not project past the step on the gauge.

b. If gauge projects too far, indicating that the valve stem is too long, grind the tip of the valve stem as necessary to make the gauge index properly.

*CAUTION: When grinding valve stem, be very careful not to overheat it. Overheating will soften the hardened stem causing rapid wear.*

### *FITTING VALVE STEMS TO GUIDES*

Correct valve stem clearance for valve guides is .0021" to .0038" for the intake valve and .0026" to .0043" for the exhaust valve.

Valves with oversize stems are available in .001", .003" and .005" larger than standard. The same valve stem to guide clearance applies for oversize stems.

Oversize reamers are required to enlarge valve guide holes to fit the oversize stems. When the reamer is turned through the valve guide it will size the hole to fit the valve stem according to the above limits.

Carefully ream the valve guide using valve guide reamer J-5830-1 for .003" oversize stems and valve guide reamer J-6621 for .005" oversize stems (Fig. 6-114). For best results when installing .005" oversize valve stem use the .003" oversize reamer first and then ream to .005" oversize. Always reface the valve seat after reaming valve guide.

*NOTE: Valves are marked .001, .003 or .005 with colored ink.*

## CYLINDER HEAD AND VALVES--ASSEMBLE

1. Install valves, valve springs, valve stem shields, valve spring retainer cups, valve stem seals and retainer cup locks using suitable spring compressor. The valve stem seals must be installed in

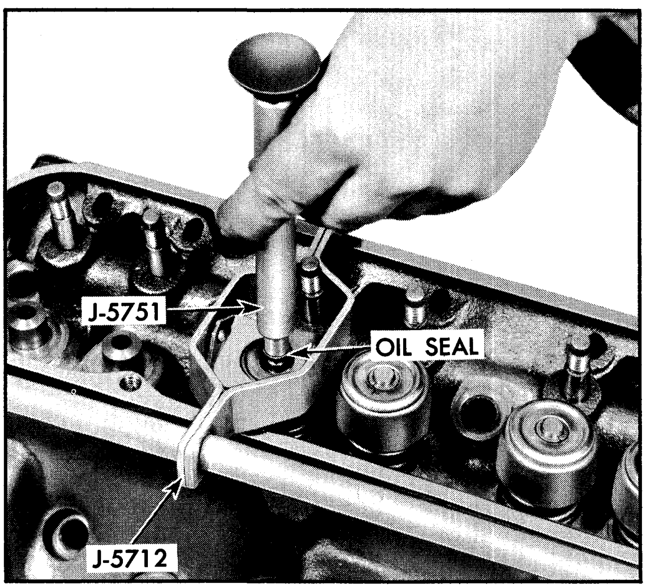



Fig. 6-115 Installing Valve Stem Seal With J-5751

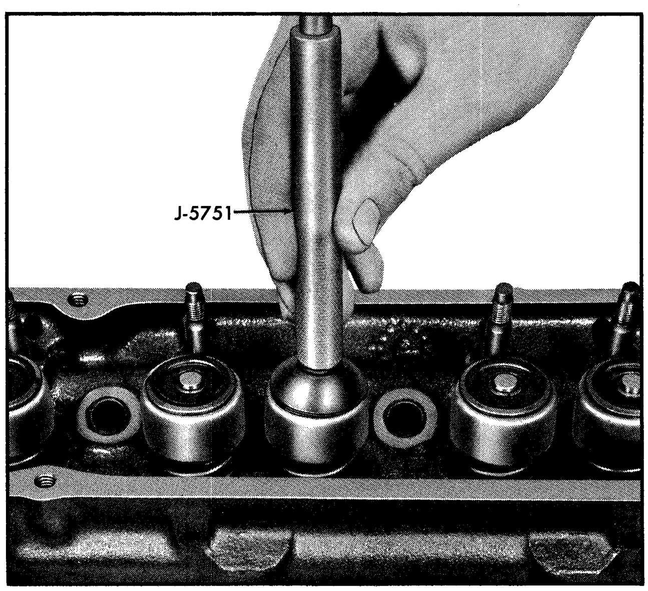



Fig. 6-116 Checking Valve Stem Seal

the second groove (from end of stem). Valve stem seal installer and tester J-5751 can be used to install this seal (Fig. 6-115).

After the valves have been installed, the suction cup end of special tool J-5751 should be used to test for leaks between the valve spring retainer cup and valve stem seal (Fig. 6-116). The suction cup will tend to be held to the valve spring retainer cup by suction when the seal is satisfactory. If a leak is detected, replace seal or valve spring retainer cup as necessary. It is important to have a positive seal between the valve spring retainer cup and the valve stem seal to prevent excessive amount of oil from being drawn down the valve stem which will cause exhaust smoke and oil consumption.

2. Install spark plugs.

## HARMONIC BALANCER—TIMING CHAIN COVER AND GASKET—TIMING CHAIN AND SPROCKETS—OIL SEAL—FUEL PUMP ECCENTRIC

### *HARMONIC BALANCER—REMOVE AND REPLACE*

1. Loosen generator at adjusting bracket and lower pivot bolt and remove fan belt from harmonic balancer. On cars equipped with power steering, also remove power steering pump belt from harmonic balancer.

2. Position fan so wide angles will be at top and bottom allowing access to balancer (Fig. 6-117).

3. Remove harmonic balancer attaching bolt and retainer washer.

4. Remove harmonic balancer by sliding it off end of crankshaft.

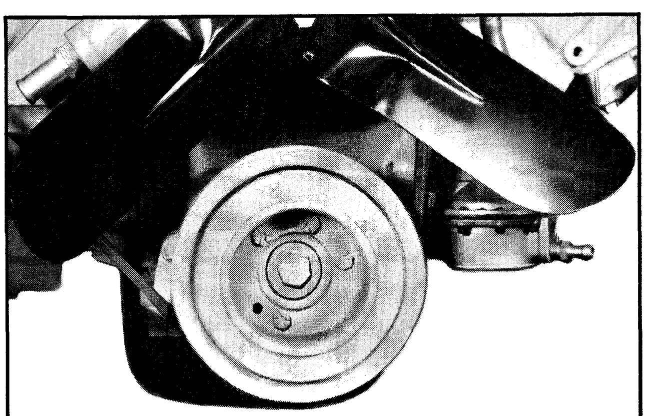


Fig. 6-117 Harmonic Balancer

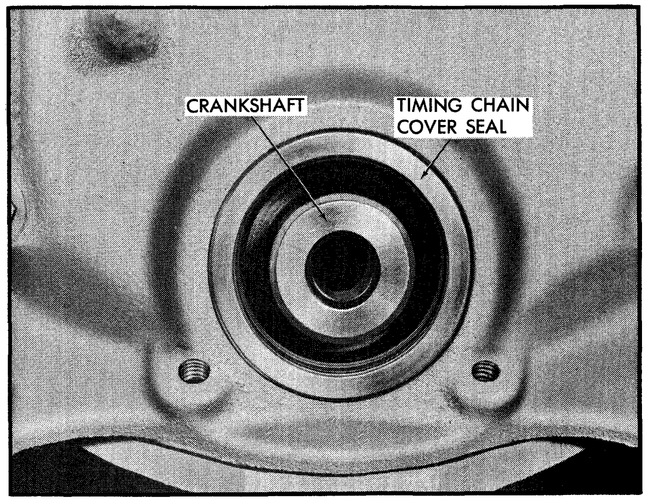



Fig. 6-118 Timing Chain Cover Seal

5. Install new harmonic balancer by reversing above steps, lining up keyway in balancer with key on crankshaft.

6. Tighten harmonic balancer attaching bolt to 130-190 lb. ft. torque.

*NOTE: Remove flywheel cover and lock flywheel before tightening balancer bolt.*

### *TIMING CHAIN COVER SEAL—REMOVE AND REPLACE*

1. Loosen alternator adjusting bolts.

2. Remove chain and accessory drive belt.

3. Remove harmonic balancer.

4. Remove timing chain cover seal by prying out of bore with a pry bar (Fig. 6-118).

5. Install new seal with lip of seal inward using seal installer J-21147.

6. Replace harmonic balancer.

7. Install drive belts and adjust to proper tension.

### *TIMING CHAIN COVER, GASKET, OR FUEL PUMP ECCENTRIC—REMOVE AND REPLACE*

1. Drain radiator and cylinder block.

2. Loosen alternator adjusting bolts.

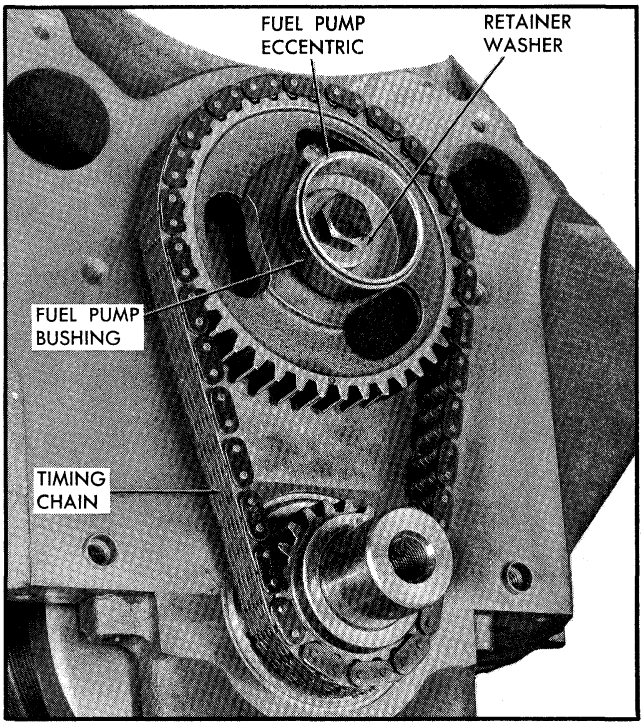



Fig. 6-119 Front of Engine With Timing Chain Cover Removed

3. Remove fan belt and accessory drive belt.

4. Remove fan and pulley from hub of water pump.

5. Disconnect upper and lower radiator hoses.

6. Remove fuel pump.

7. Remove harmonic balancer.

8. Remove front four oil pan to timing chain cover screws.

9. Remove timing chain cover to block attaching bolts and nuts and timing chain cover to intake manifold bolt.

10. Pull timing chain cover forward to clear studs and remove.

11. Remove "O" ring seal from recess in intake manifold water recirculation passage.

12. Remove timing chain cover gasket and thoroughly clean gasket surfaces on block and cover. Use care to prevent gasket particles and other foreign material from falling into oil pan.

13. Inspect front oil pan gasket and replace if damaged. If new gasket is installed, it should be cemented to oil pan.

14. If new fuel pump eccentric and bushing are to be installed, remove camshaft sprocket retainer bolt and retaining washer and remove the eccentric and bushing. Place fuel pump bushing over eccentric with rolled flange toward camshaft sprocket (Fig. 6-119).

*NOTE: Bushing retaining flange should be between eccentric and sprocket for retention of bushing in operation.*

Install bushing and eccentric, indexing tang on eccentric with keyway cutout in camshaft sprocket. Insert retaining screw with retainer washer and tighten securely.

15. Position new timing chain cover gasket over studs and dowels against block.

16. Transfer water pump to new timing chain cover if new cover is to be installed.

17. Install new "O" ring seal in water recirculation passage of intake manifold.

18. Position timing chain cover on engine indexing over dowels, install bolts and nuts and tighten securely.

19. Install four oil pan to timing chain cover screws and tighten to 10-15 lb. ft. torque.

20. Install harmonic balancer, retainer bolt with retainer, and tighten to 130-190 lb. ft. torque.

21. Connect lower radiator hose to pump inlet.

22. Position pulley and fan on water pump hub and install attaching bolts. Tighten to 15-25 lb. ft. torque.

23. Install power steering pump and belt on cars so equipped.

24. Install generator adjusting strap.

25. Install fan belt and accessory drive belts. Adjust to proper tension.

26. Install fuel pump.

27. Refill cooling system and check for leaks.

## TIMING CHAIN AND SPROCKETS— REMOVE AND REPLACE

1. Remove timing chain cover, making certain "O" ring seal and hollow dowels are retained for installation at assembly.

2. Remove fuel pump eccentric, bushing and timing chain cover oil seal.

3. Align timing marks to simplify proper positioning of sprockets during reassembly (Fig. 6-120).

4. Slide timing chain and sprockets off ends of crankshaft and camshaft.

5. Install new timing chain and/or sprockets making sure marks on timing sprockets are aligned exactly on a straight line passing through the shaft centers (Fig. 6-120). Camshaft should extend through sprocket so that hole in fuel pump eccentric will locate on shaft.

6. Install fuel pump eccentric and bushing, indexing tab on eccentric with keyway cutout in sprocket. Install retainer bolt with retainer washer and tighten securely.

7. Making certain hollow dowels are in place in block, place timing chain cover gasket over studs and dowels.

8. Install timing chain cover, making sure "O" ring seal is in place.

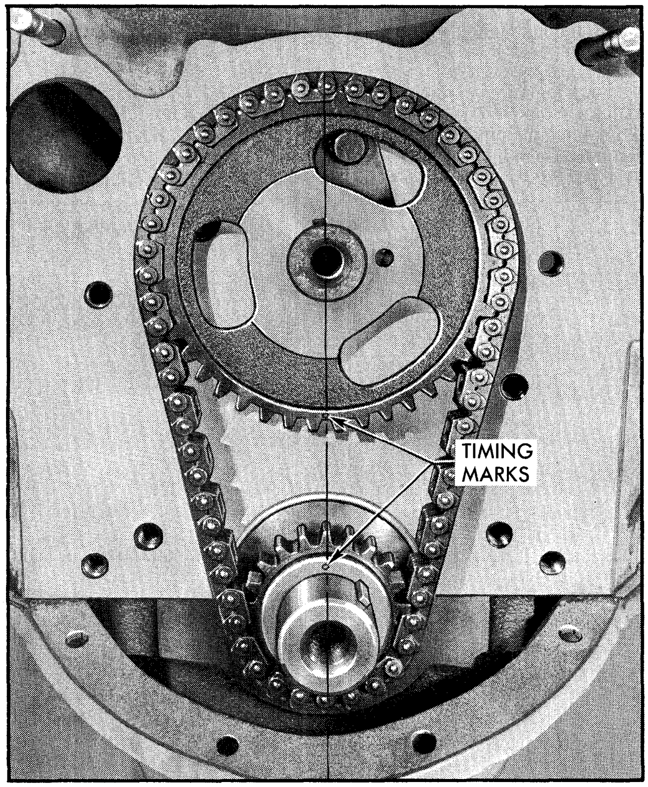



Fig. 6-120 Aligning Timing Marks

### CAMSHAFT AND/OR CAMSHAFT BEARING—REMOVE AND REPLACE

The camshaft and camshaft bearings can be replaced with engine installed in car or with engine removed and disassembled for overhaul; however, to replace the rear camshaft bearing without removing and completely disassembling engine, the propeller shaft, transmission and clutch housing must first be removed.

To replace the camshaft and/or the rear center, center, front center or front camshaft bearing without removing and completely disassembling the engine, proceed as follows:

1. Drain radiator.

2. Remove carburetor air filter.

3. Disconnect all water hoses, vacuum hose and spark plug wires.

4. Disconnect carburetor linkage, fuel lines and wires to thermogage unit.

5. Remove hood latch bracket.

6. Remove radiator, fan and pulleys.

7. On air conditioned cars, remove alternator mounting bracket and alternator.

8. Remove crankcase ventilator hose, and remove both rocker arm covers and gaskets.

9. Remove distributor hold-down clamp and remove distributor.

10. Remove intake manifold and gaskets.

*NOTE: Make certain "O" ring seal between intake manifold and timing chain cover is retained and installed during assembly.*

11. Remove push rod cover.

12. Loosen rocker arm ball retaining nuts so that rocker arms can be disengaged from push rods and turned sideways.

13. Remove push rods and hydraulic lifters. Store push rods in stand J-5709 and lifters in lifter box J-5763 so they can be reinstalled in original positions.

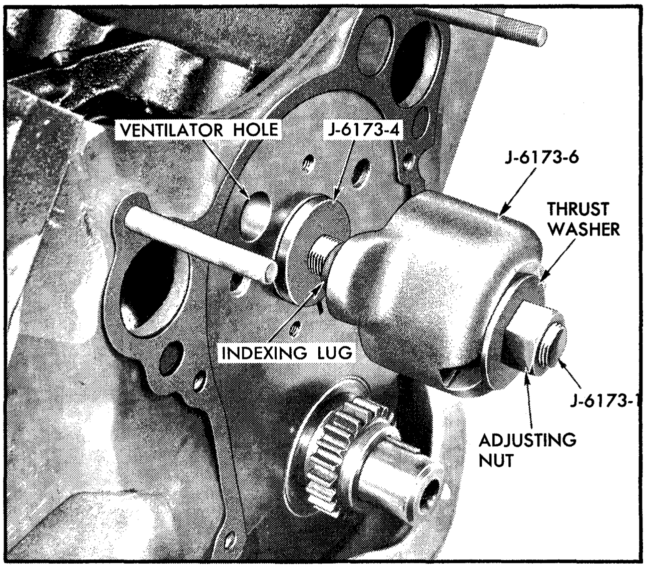



Fig. 6-121 Positioning Index Collar

14. Remove harmonic balancer.

15. Remove fuel pump.

16. Remove four oil pan to timing chain cover screws.

17. Remove timing chain cover and gasket.

18. Remove fuel pump eccentric and fuel pump bushing.

19. Align timing marks on timing chain sprockets and remove timing chain and sprockets.

20. Remove camshaft thrust plate.

21. Carefully pull camshaft from engine, exercising caution so as not to damage bearings in block.

*NOTE: The clearance for camshaft removal is very limited and, in cases where engine mounts are worn excessively, it may be necessary to raise the front of the engine to permit removal.*

22. Stuff clean rags through openings in engine block as an aid in preventing foreign material or parts of bearing remover tool from dropping into block.

*CAUTION: It is imperative that operator exercise extreme caution when inserting bearing remover adapters or key through openings in engine block to prevent them from dropping into engine.*

CAMSHAFT BEARING--REMOVE

1. Insert remover adapter J-6173-4 into front bearing to act as a support for shaft J-6173-1 (Fig. 6-121).

*NOTE: If front bearing is to be replaced, insert installer adapter in center bearing to act as support for shaft.*

2. Insert replacer adapter J-6173-3 into rear of bearing to be removed so that shoulder on remover bears against rear edge of bearing.

*NOTE: If rear bearing is to be removed, it will be necessary to remove camshaft rear plug.*

3. Place indexing collar J-6173-6 on threaded end of shaft with open side toward unthreaded end and start thrust washer and nut on shaft (Fig. 6-121).

4. Insert shaft and indexing collar through remover and replacer adapters and position lug on indexing collar in ventilator hole in front of block (Fig. 6-121). This indexes the shaft so that it cannot rotate.

5. Slip key J-6173-5 into notches in shaft behind bearing to be removed (Fig. 6-122).

6. Turn nut on front of shaft to pull key against remover adapter J-6173-4, then continue to turn nut until bearing is pulled out of its hole.

CAMSHAFT BEARING -- REPLACE

1. Place a clean rag against each side of the transverse member just below the bearing hole to

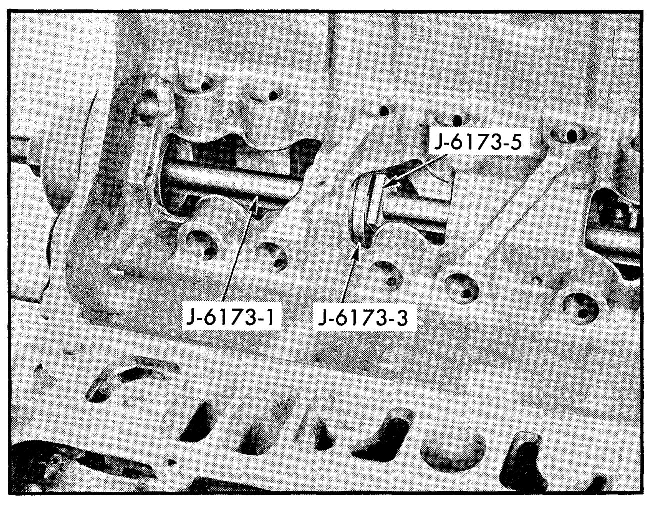



Fig. 6-122 Preparing to Remove Camshaft Bearing

catch any shavings and carefully clean up the hole. All scratches or nicks in the cast iron should be smoothed with a scraper or file, being careful not to get any chips in cylinder head gallery feed hole. Chamfer the rear edge of the hole slightly to reduce the possibility of shaving down the outer diameter of the bearing when it is installed.

2. Insert remover adapter J-6173-4 into front bearing to act as a support for the shaft.

*NOTE: If front bearing is being replaced, insert remover adapter in center bearing to act as support for the shaft.*

3. Insert pilot J-6173-7 into hole in which bearing is to be installed.

4. Coat outside of new bearing with oil and place it over replacer adapter J-6173-3, indexing notch in edge of bearing with pin on replacer adapter.

*NOTE: The notch in the edge of the bearing is used to properly position the bearing, with respect to the oil holes, when it is installed. When bearings are installed in production, the notches all face the front except the one in the rear bearing. In the field it is necessary to install bearings with the notch facing the rear.*

5. Position replacer adapter J-6173-3, with bearing in position against shoulder, against rear of hole in which bearing is to be installed (Fig. 6-123). Index mark on shoulder of replacer must point down (toward crankshaft side) to properly position bearing.

6. Insert shaft with indexing collar, thrust washer, and nut through remover, pilot and replacer adapters and index lug on collar with ventilation hole in front of block (Fig. 6-121).

7. Slip key J-6173-5 into notches in shaft behind replacer adapter J-6173-3 and tighten nut to start bearing into hole (Fig. 6-123). Continue to tighten nut until bearing has been pulled completely into its hole. When properly positioned, it will be approximately flush with both sides of the transverse member.

*NOTE: Rear bearing should be pulled in until front edge is flush with block. This will leave shoulder at end of counterbore for camshaft rear plug visible behind bearing.*

8. Remove remover and replacer set J-6173.

9. Visually observe that holes in bearing line up with drillings in block.

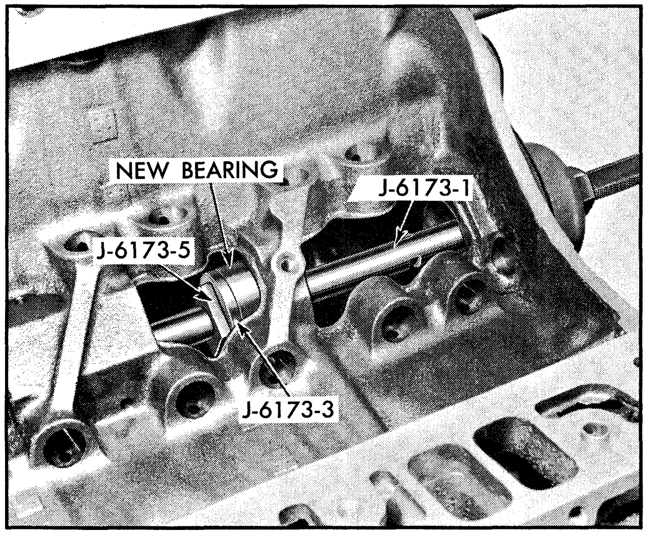



Fig. 6-123 Preparing to Install Camshaft Bearing

10. Carefully remove rags used to catch particles of metal and use magnet or vacuum cleaner to make sure that all metal particles are removed from block surfaces and oil drillings.

CAMSHAFT - REPLACE

1. Coat inner diameters of all camshaft bearings with oil and carefully install camshaft. Rotate camshaft through several revolutions to make sure it is completely free. If any tight spots are found, remove camshaft and very carefully polish down the center journal slightly. If still not free, polish the front and rear journals slightly. If any particular bearing causes binding of the camshaft, replace that bearing also.

*NOTE: Front center and rear center journals should not be polished except to remove slight roughness or scratches. Slight warpage of the camshaft is not harmful provided the journals are polished down until the camshaft rotates freely in its bearings.*

2. With camshaft properly seated, install camshaft thrust plate and tighten bolts 10-25 lb. ft. torque.

3. Install timing chain sprockets and timing chain, making sure marks on sprockets are aligned properly (Fig. 6-120).

4. Install fuel pump eccentric and bushing. Tighten camshaft sprocket retaining bolt 30-45 lb. ft. torque.

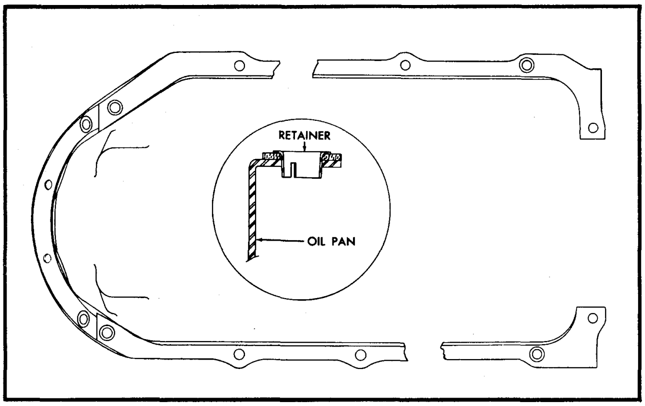



Fig. 6-124 Installing Oil Pan Gasket Retainers

5. Install timing chain cover dowels and new gasket and tighten cover to cylinder block bolts and cover to block stud nuts 20-35 lb. ft. torque.

6. Insert four oil pan to timing chain cover screws and tighten 10-15 lb. ft. torque.

7. Install fuel pump and tighten bolts 15-30 lb. ft. torque.

8. Install harmonic balancer. Tighten bolt 130-190 lb. ft. torque.

9. Install hydraulic lifters and push rods, making certain they are replaced in their original positions.

10. Engage rocker arms on push rods and tighten rocker arm ball retaining nuts 15-25 lb. ft. torque.

11. Install push rod cover. Tighten bolts 25-70 lb. in. torque.

12. Install intake manifold and gasket. Tighten bolts 30-45 lb. ft. torque.

*NOTE: "O" ring seal must be installed between intake manifold and timing chain cover before manifold is securely positioned.*

13. Install distributor, positioning rotor pointer to number six cylinder, and install distributor hold-down clamp. Tighten clamp retaining screw 15-25 lb. ft. torque.

14. Install crankcase ventilator outlet pipe and both rocker arm covers and gaskets. Tighten cover bolts 45-80 lb. in. torque.

15. If generator bracket and generator were removed, install and tighten bolts 10-25 lb. ft. torque.

16. Install fan and pulleys.

17. Install radiator, tightening all bolts securely.

18. Install hood latch bracket and tighten bolts 15-20 lb. ft. torque.

19. Connect carburetor linkage, fuel lines and thermogage unit.

20. Connect all water hoses, vacuum hose and spark plug wires.

21. Install carburetor air filter.

22. Refill cooling system and check for leaks.

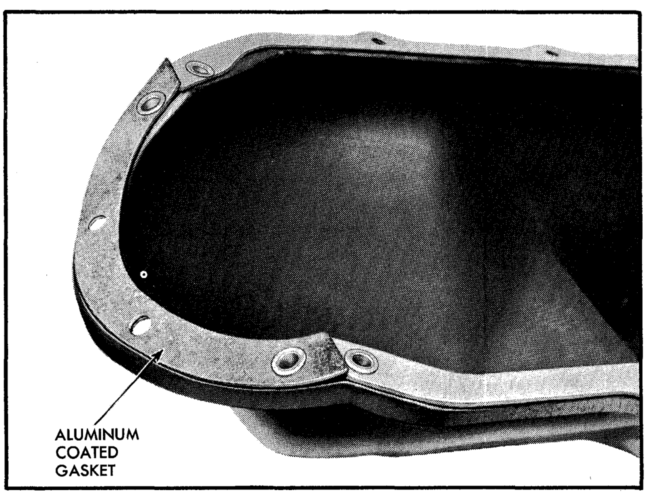



Fig. 6-125 Front Oil Pan Gasket Overlapping Side Gaskets

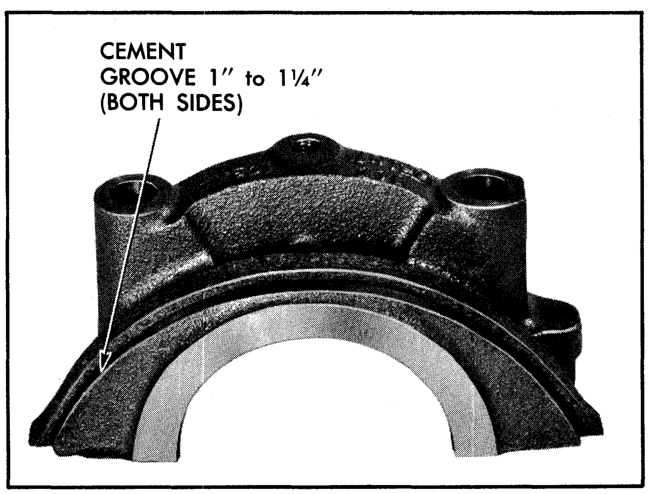



Fig. 6-126 Rear Oil Pan Gasket Positioned in Bearing Cap

## OIL PAN AND/OR OIL PAN GASKETS—REMOVE AND REPLACE

### REMOVE

1. Remove engine, clutch (SM) and transmission as an assembly from vehicle.

2. Remove clutch (SM) and transmission from engine.

3. Place engine on a suitable stand.

4. Remove oil pan.

### REPLACE

1. Install new gaskets on oil pan using gasket retainers (Figs. 6-124, 125).

2. Install new oil pan gasket in rear main bearing cap (Fig. 6-126).

3. Install oil pan into position and torque retaining screws 10-15 lb. ft.

4. Remove engine from stand.

5. Install clutch (SM) and transmission to engine and install complete assembly in vehicle.

## OIL PUMP—REMOVE AND REPLACE

1. Remove engine oil pan (See "Oil Pan - Remove and Replace").

2. Remove oil pump attaching bolts while holding oil pump in place. Carefully lower oil pump away from block with one hand while removing oil pump drive shaft with other hand (Fig. 6-127).

3. Position drive shaft in distributor and oil pump drive gears. Place pump against block using new gasket between pump and block. Index drive shaft with pump drive gear shaft. Install two attaching screws with lockwashers and tighten securely.

*NOTE: Removal and installation of pump does not affect ignition timing, since the oil pump and distributor drive gear is mounted on the distributor shaft.*

4. Install oil pan

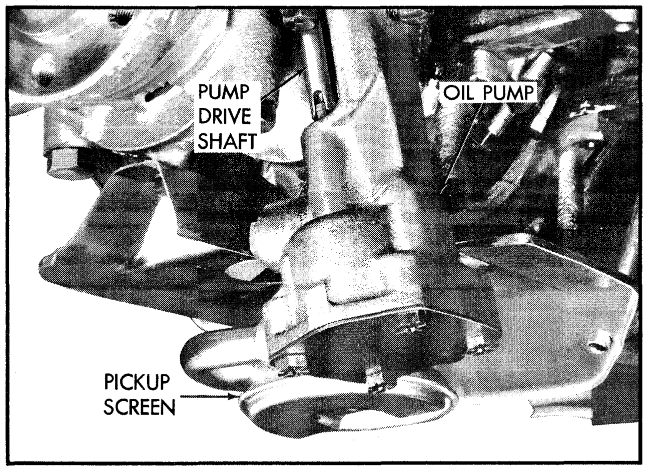



Fig. 6-127 Oil Pump and Oil Pump Drive Shaft

## OIL PUMP—RECONDITION

### DISASSEMBLE

1. Remove pressure regulator spring retainer, spring, and pressure regulator ball.

2. Remove screws retaining cover to oil pump body and remove cover.

3. Remove driven gear and drive gear with shaft.

*NOTE: Oil pump screen should not be removed from pump body. Be careful not to loosen screen.*

### CLEAN AND INSPECT

1. Clean all parts thoroughly. Screen must be thoroughly cleaned by using a fluid such as used for carburetor cleaning.

2. Inspect pressure regulator spring (Fig. 6-128) for distortion, cracks, and wear on sides.

3. Inspect pressure regulator ball to see that it is not nicked or otherwise damaged.

4. Inspect pump body, driven gear shaft and cover for evidence of wear.

5. Inspect pump gears and end of drive gear shaft for wear (Fig. 6-128).

6. Inspect oil pump drive shaft (distributor to pump shaft) for evidence of wear and cracks.

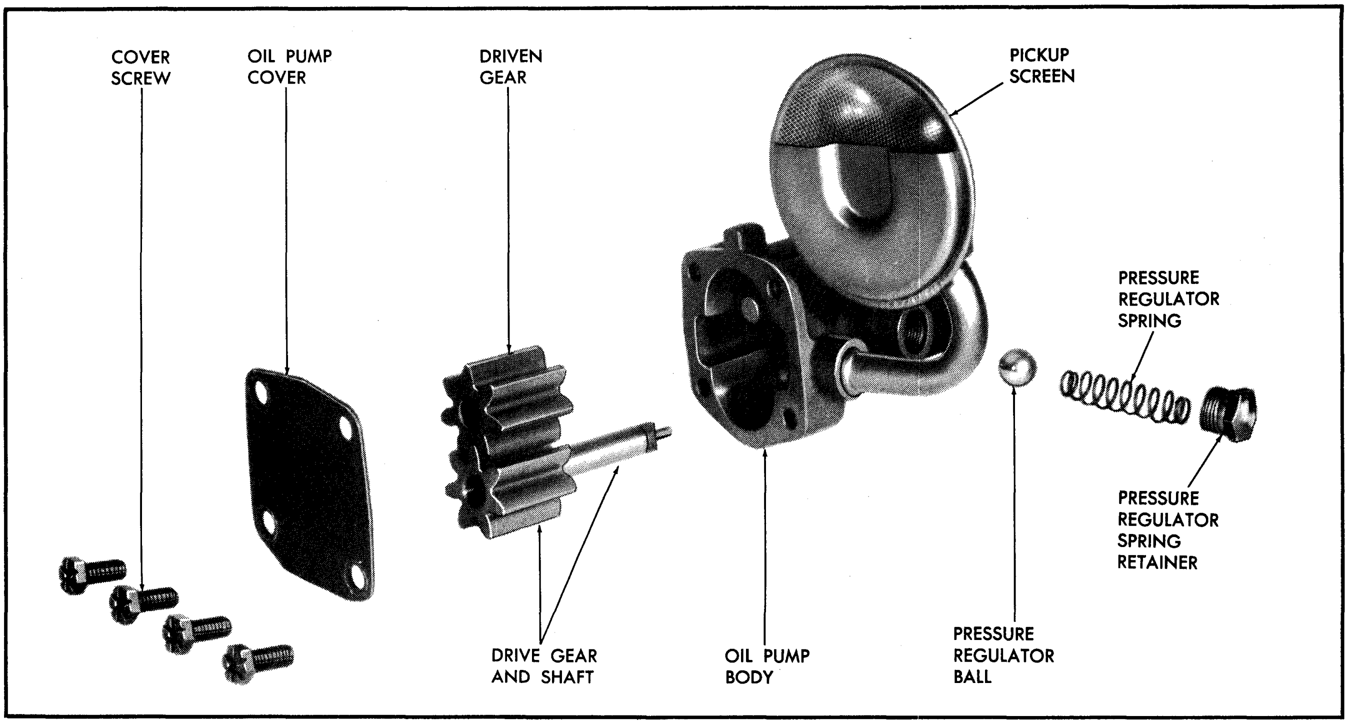



Fig. 6-128 Oil Pump - Exploded View

ASSEMBLE

1. Install drive and driven gears.

2. Install cover and turn drive shaft by hand to ensure that it turns freely.

3. Install pressure regulator ball, spring and retainer.

*CAUTION: Do not attempt to change oil pressure by varying length of pressure regulator valve spring.*

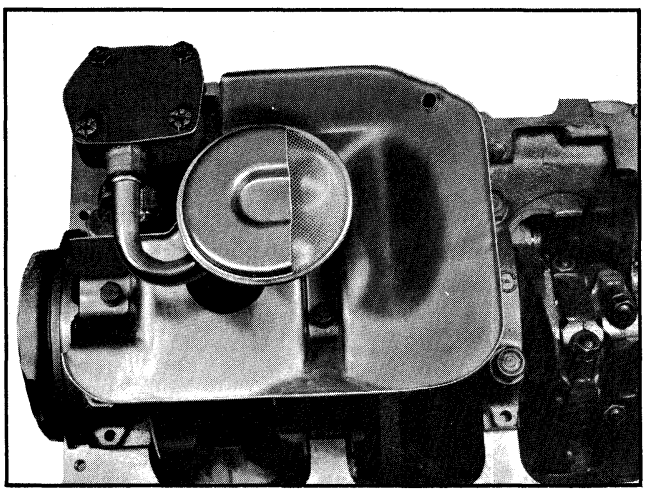


Fig. 6-129 Oil Pump and Baffle

***REAR MAIN BEARING OIL SEAL— REMOVE AND REPLACE***

1. Remove oil pan (See "Oil Pan - Remove and Replace").

2. Remove oil pump and baffle (Fig. 6-129).

3. Remove rear main bearing cap.

4. Use tool shown in Fig. 6-130 made from brass bar stock to pack upper seal as follows:

a. Insert tool against one end of the oil seal in the cylinder block and drive the seal gently into the groove until the tool bottoms.

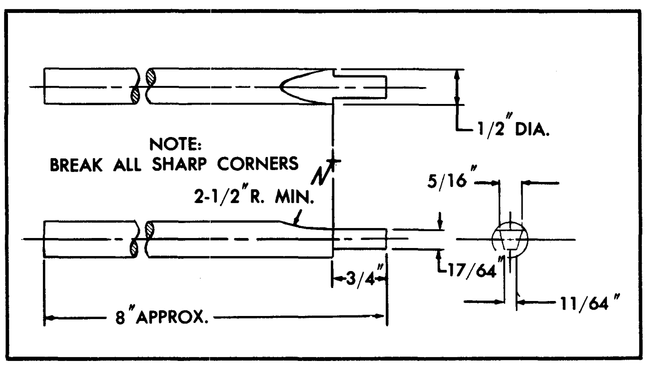



Fig. 6-130 Rear Main Bearing Oil Seal Tool

b. Remove the tool and repeat at the other end of the seal in the cylinder block.

5. Clean the block and bearing cap parting line thoroughly.

6. Form a new seal in the cap (Fig. 6-131).

7. Remove the newly formed seal from the cap and cut four (4) pieces approximately 3/8" long from this seal.

8. Work two 3/8"pieces into each of the gaps which have been made at the end of the seal in the cylinder block. Without cutting off the ends, work these seal pieces in until flush with the parting line and no fibers are protruding over the metal adjacent to the groove.

9. Form another new seal in the cap (Fig. 6-131).

10. Assemble the cap to the block and tighten to 110-130 lb. ft. torque.

11. Remove the cap and inspect the parting line to insure that no seal material has been compressed between the block and the cap. Clean as necessary.

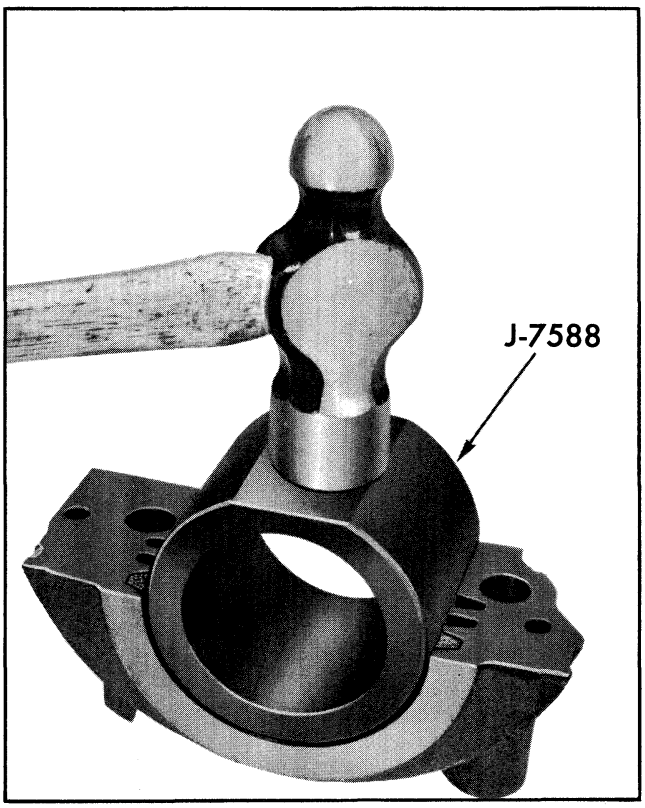



Fig. 6-131 Forming New Seal in Cap

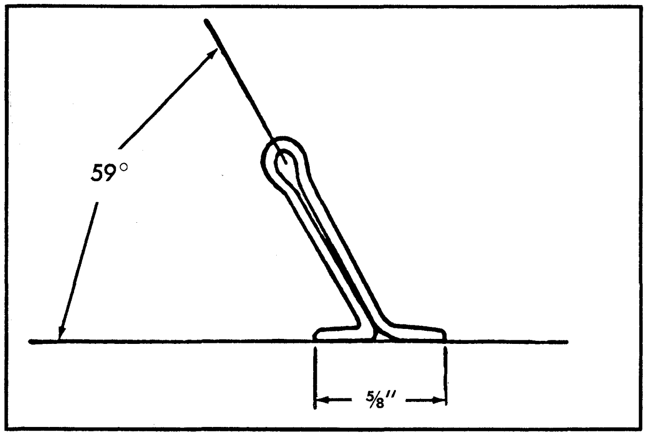



Fig. 6-132 Tool for Removing Upper Half of Main Bearing

12. Apply a 1/16" bead of sealer from the center of seal across to the external cork groove.

13. Reassemble the cap. Tighten to 110-130 lb. ft. torque.

14. Install baffle and oil pump.

15. Install oil pan (See "Oil Pan - Remove and Replace").

### *MAIN BEARINGS—REMOVE AND REPLACE*

1. Remove oil pan. (See "Oil Pan - Remove and Replace").

2. To gain access to rear center bearing cap, remove oil baffle. To gain access to rear main, remove oil pump in addition to oil baffle.

3. Remove bearing cap of main bearing to be replaced.

4. Make a tool for removing upper half of bearing shell as shown in Fig. 6-132. KMO 734 can also be used.

5. Insert tool in oil hole of crankshaft and rotate crankshaft in usual direction of rotation. This will cause bearing to be moved from between shaft and bearing seat.

6. Oil bearing surface of shell and install by inserting plain end of bearing shell at indented side of bearing seat and gently rotating shell into place by turning shaft.

7. Install new bearing lower half by inserting in bearing cap so indentation in shell and cap coincide.

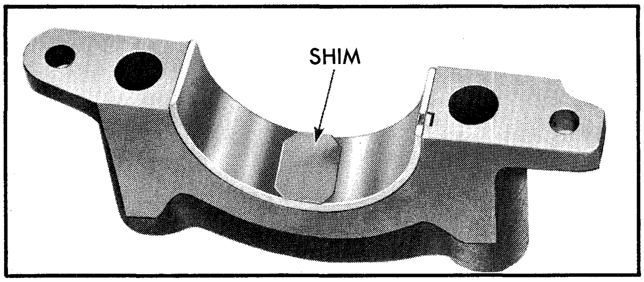



Fig. 6-133 .002 Shim Positioned in Cap for Checking Bearing Clearance

8. Install bearing cap and check fit of bearing using plastigage or shim stock as outlined below.

*CAUTION: Under no circumstances should bearing caps be filed or shimmed in an effort to effect a fit.*

PLASTIGAGE METHOD OF DETERMINING MAIN BEARING CLEARANCE

1. Place a .002" brass shim between the crankshaft journal and the lower bearing in each bearing cap next to the one being checked (Fig. 6-133).

Tighten all cap bolts to proper torque as follows: rear - 110-130 lb. ft., all others 90-110 lb. ft. This causes the crankshaft to be forced against the upper bearing and insures an accurate measurement of the total clearance.

2. Remove the bearing cap of the bearing to be checked. Wipe the bearing and the journal free of oil.

3. Place a piece of Plastigage the length of the bearing (parallel to the crankshaft) on the journal or bearing surface (Fig. 6-134). Install the cap and tighten cap bolts to proper torque.

*NOTE: Do not turn crankshaft with Plastigage in place.*

4. Remove bearing cap and using Plastigage scale on envelope measure width of compressed Plastigate before removing it from the bearing or journal (Fig. 6-135). If the bearing clearance is between .0005" and .0020", the clearance is satisfactory. If the clearance is more than .0020", replace the bearing with the next size undersize bearing and recheck clearance. Bearings are available in standard size, .001" and .002" undersize.

5. Install a new rear main bearing oil seal in the cylinder block and main bearing cap if the rear main bearing was checked and/or replaced (see page 6- ).

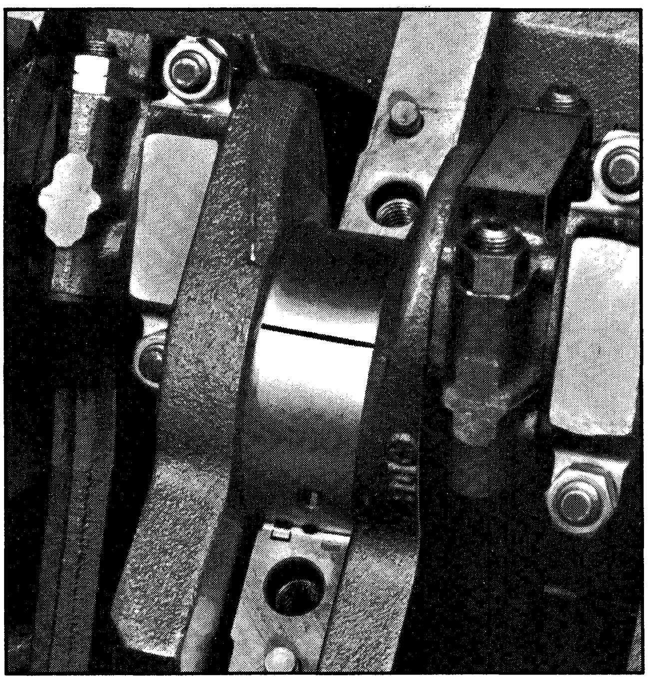


Fig. 6-134 Plastigage on Journal

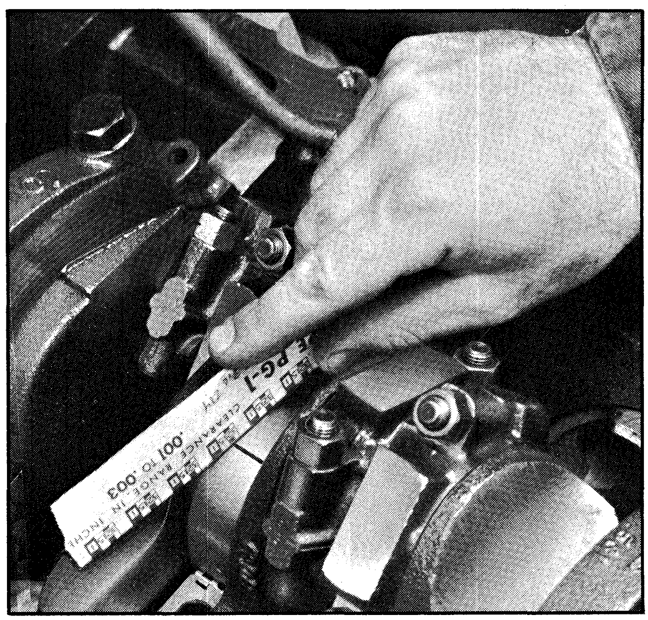


Fig. 6-135 Measuring Plastigage

***CONNECTING ROD BEARINGS—***
***REMOVE AND REPLACE***

1. Remove oil pan. (See "Oil Pan - Remove and Replace").

2. To gain access to numbers 5, 6, 7, or 8 connecting rod caps it will be necessary to remove oil pump screen and oil baffle.

3. Rotate crankshaft as necessary to bring crankpin carrying bearing to be replaced straight down (Fig. 6-136).

4. Remove bearing cap of bearing to be replaced.

5. Install connecting rod bolt guide set J-5239 on connecting rod bolts (Fig. 6-137).

6. Push piston and rod assembly up far enough to allow removal of bearing shell. Remove bearing shells from rod and cap.

7. Inspect crankpin for damage, out-of-round, and taper.

8. Reassemble cap and rod with new bearing shells and check fit using Plastigage or shim stock as outlined below.

*CAUTION: Under no circumstances should a bearing cap be filed or shimmed in an effort to effect a fit.*

PLASTIGAGE METHOD OF DETERMINING CONNECTING ROD BEARING CLEARANCE

1. Remove the cap of the bearing to be checked. Wipe the bearing and the crankpin free of oil.

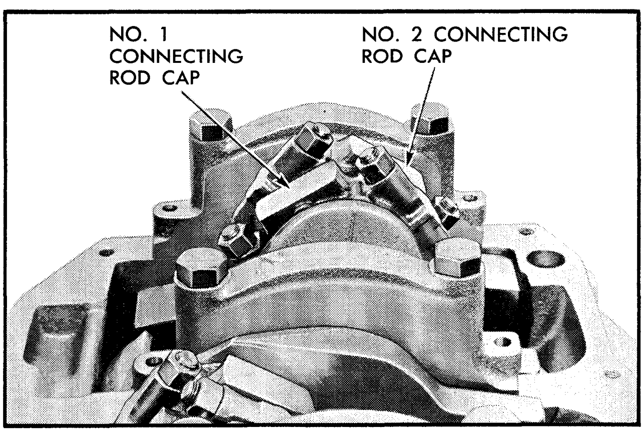



Fig. 6-136 Crankshaft Positioned for Removal of No. 1 and No. 2 Connecting Rod Caps

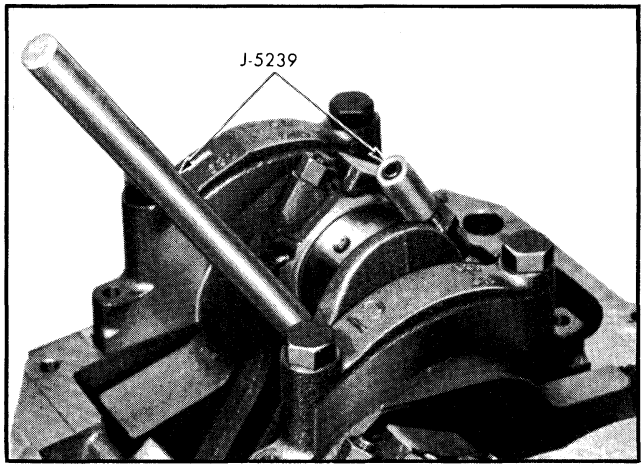



Fig. 6-137 J-5239 Positioned for Removal of Rod Connecting Bearing Shell

2. Place a piece of Plastigage the length of the bearing (parallel to the crankshaft) on the crankpin or bearing surface, Fig. 6-138. Install the cap and tighten cap bolts to 45 lb. ft.

*NOTE: Do not turn crankshaft with Plastigage in place.*

3. Remove bearing cap and using Plastigage scale on envelope measure width of compressed Plastigage before removing it from the crankpin or bearing (Fig. 6-139). If the bearing clearance is between .0005" and .0025" the clearance is satisfactory. If the clearance is more than .0025" replace the bearing with the next size undersize bearing and recheck clearance. Bearings are available in .001" and .002" undersize.

4. Rotate the crankshaft after bearing adjustment to be sure bearings are not tight.

***CONNECTING ROD AND PISTON ASSEMBLY—***
***REMOVE AND REPLACE***

REMOVE

1. Remove oil pan and if number 5, 6, 7 or 8 rod and piston assembly is to be removed, remove oil baffle and oil pump. (See "Oil Pan - Remove and Replace").

2. Remove intake manifold and cylinder head on bank from which piston is to be removed.

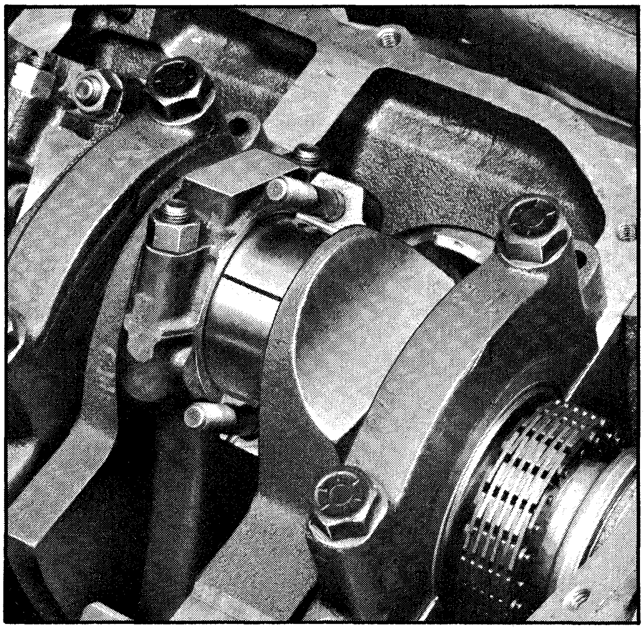


Fig. 6-138 Plastigage on Crankpin

3. Rotate crankshaft so crankpin carrying assembly to be replaced projects straight downward (Fig. 6-136).

4. Remove bearing cap and install connecting rod bolt guide set J-5239.

5. Carefully remove connecting rod and piston assembly by pushing out with knurled handle of long guide (Fig. 6-137).

REPLACE

1. Install connecting rod bolt guide set on connecting rod bolts with long handle guide on same side as oil groove in rod.

2. Using suitable ring compressor insert piston and connecting rod assembly into cylinder so that notch in top of piston is toward front of engine. This will place the oil groove of the connecting rod so that it will direct oil against the opposite cylinder wall.

3. From beneath engine, pull connecting rod, with bearing shell in place, into position against crankpin.

4. Remove guide set J-5239. Install bearing cap and cap nuts and tighten to 40-46 lb. ft. torque.

5. Replace oil pump screen and oil baffle, if they were removed.

6. Install cylinder head and intake manifold.

7. Replace oil pan, using new gaskets. Tighten oil pan screws to 10-15 lb. ft. torque.

## CONNECTING ROD AND PISTON ASSEMBLY—RECONDITION

*NOTE: Use care at all times when handling and servicing connecting rods and pistons. To prevent possible damage to these units, do not clamp rod or piston in vise since they may become distorted. Do not allow pistons to strike against one another, against hard objects, or bench surfaces, since distortion of piston contour or nicks in the soft aluminum material may result.*

CONNECTING ROD AND PISTON -- DISASSEMBLE

1. Remove piston rings using suitable piston ring remover.

*NOTE: It is important that rings be removed carefully to prevent scratching or burring of ring grooves and lands.*

2. Using a suitable arbor press place the spring and plunger into the bore of the base support and position on an arbor press with the pilot plunger indexed in the bottom of piston pin bore. See Fig. 6-140 insert for correct base support and pilot plunger for the type pistons being serviced.

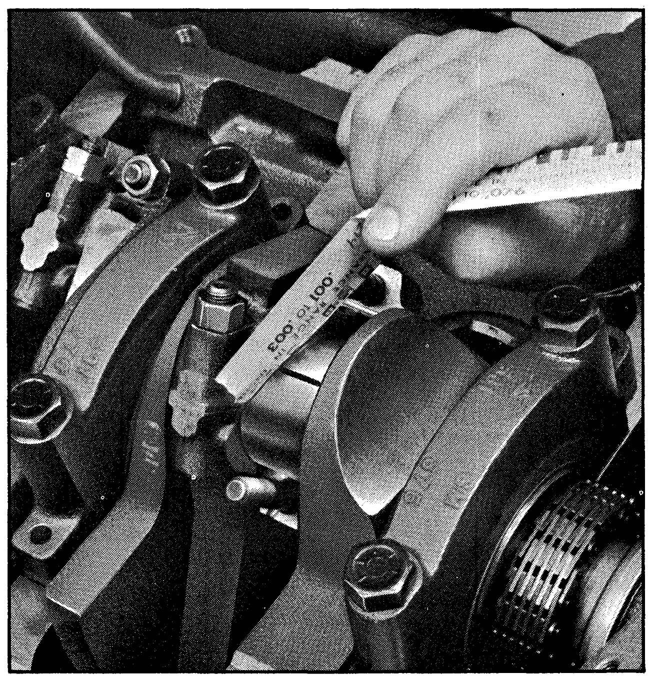


Fig. 6-139 Measuring Plastigage

3. Place tool J-6901-5 between connecting rod and piston boss (Fig. 6-140).

4. Place tool J-6901-3 (Fig. 6-140) in piston pin and press piston pin down until pilot bottoms in tool J-6901.

5. Remove tool J-6901-5 from between connecting rod and piston boss.

6. Remove pilot plunger and spring from tool J-6901.

7. Place end of piston pin in tool J-6901 and place on arbor press.

8. Using tool J-6901-3 (Fig. 6-140) press pin out of piston and connecting rod.

9. Remove bearing cap and bearing.

CONNECTING ROD AND PISTON--
CLEAN AND INSPECT

1. Clean carbon, varnish, and gum from piston surfaces, including underside of piston head. Clean ring grooves, and oil slots in oil ring groove, using suitable cleaning tools and solvent.

2. Clean piston pin, rod, cap, bolts and nuts in suitable solvent. Reinstall cap on connecting rod to assure against subsequent mixing of caps and connecting rods.

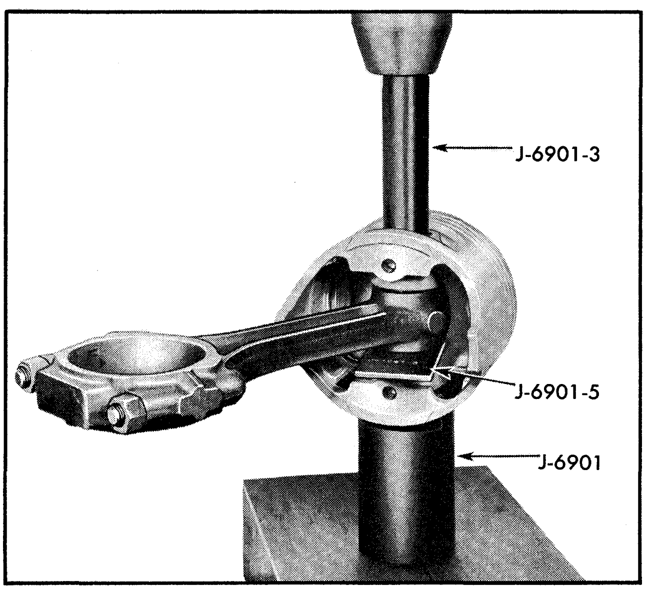



Fig. 6-140 Piston Positioned in Arbor Press for Removal of Pin

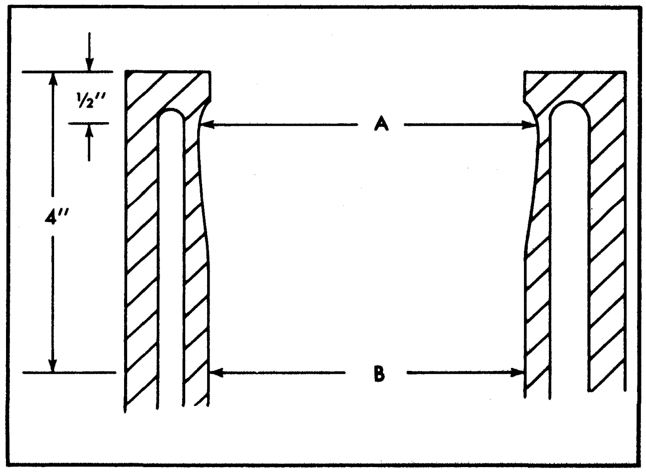



Fig. 6-141 Normal Cylinder Wear Pattern

3. Carefully examine piston for rough or scored bearing surfaces; cracks in skirt or head; cracked, broken, or worn ring lands; scored, galled, or worn piston bosses. Damaged or faulty pistons should be replaced.

*NOTE: If piston pin bosses are rough or worn out-of-round and the piston is otherwise serviceable, the pin bosses may be honed for oversize pins. Before fitting oversize pins, however, it is advisable to check fit the piston in bore.*

4. Inspect piston pin for scoring, roughness, or uneven wear.

5. Inspect bearing shells to see that they are serviceable. Fit of bearings should be checked when engine is being assembled.

CYLINDER BORES--INSPECT

Inspect cylinder bores for out-of-round or excessive taper with an accurate cylinder gauge J-8087 or comparable, at top, middle and bottom of bore. Measure cylinder bore parallel and at right angles to the center line of the engine to determine out-of-round. Variation in measure from top to bottom of cylinder indicates the taper in the cylinder.

Fig. 6-141 illustrates area in cylinder where normal wear occurs. If the measurement at dimension A, taken at a point one half inch down from top of cylinder is .007" in excess of dimension B taken at a point four inches down from top of cylinder, this indicates the necessity of cylinder boring and installing new rings and pistons. Cylinder bore can be measured by setting the cylinder gauge dial at zero

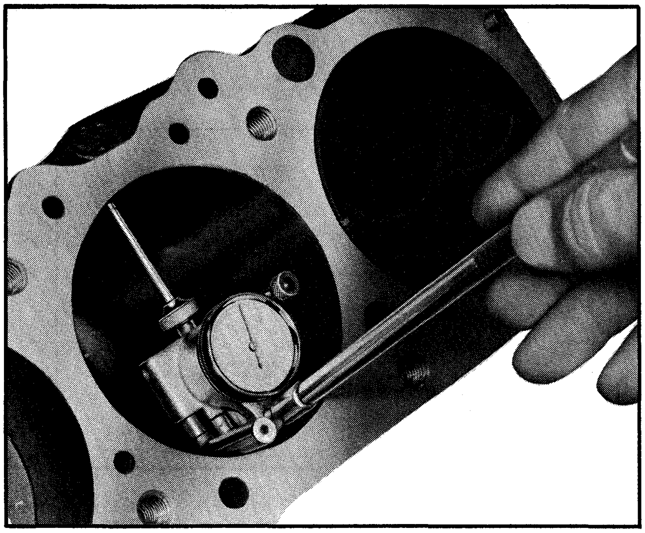


Fig. 6-142 Measuring Cylinder Bore

in the cylinder at the point of desired measurement. Lock dial indicator at zero before removing from cylinder, and measure across the gauge contact points with outside micrometer with the gauge at the same zero setting when removed from the cylinder (Fig. 6-142 and 6-143).

Fine vertical scratches made by ring ends will not cause excessive oil consumption, therefore, honing to remove is unnecessary.

HONING OR BORING

If a piston in excess of .005" oversize is to be installed, the cylinder should be bored, rather than honed, to effect a true bore.

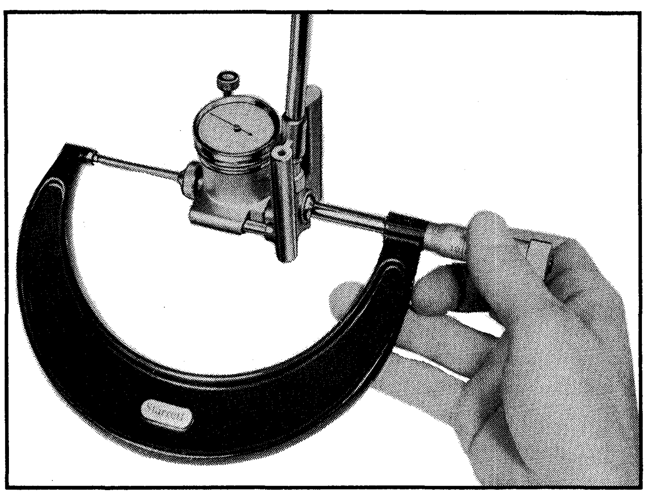


Fig. 6-143 Measuring Cylinder Gauge

When honing to eliminate the possibility of honing taper into the cylinder when installing a .005" oversize, full strokes of the hone in cylinder should be made in addition to checking measurement at top, middle and bottom of bore repeatedly.

When boring always be sure the crankshaft is out of the way of the boring cutter when boring each cylinder. Crankshaft bearings and other internal parts must be covered or taped to protect them during boring or honing operation. When taking the final cut with a boring bar leave .001" on the diameter for finish honing to give the required piston to cylinder clearance specifications.

*NOTE: Honing or boring operation must be done under close supervision so that specified clearance between pistons, rings, and cylinder bores is maintained.*

By measuring the piston to be installed at the sizing points (Fig. 6-144) and adding the mean of the clearance specification, the finish hone cylinder measurement can be determined. It is important that both the block and piston be measured at normal room temperature, 60°-90°F.

After final honing and before the piston is checked for fit, each cylinder bore must be thoroughly cleaned. Use soapy water solution and wipe dry to remove all traces of abrasive. If all traces of abrasive are not removed, rapid wear of new rings and piston will result.

Intermixing different size pistons has no effect on engine balance as all Pontiac pistons from standard

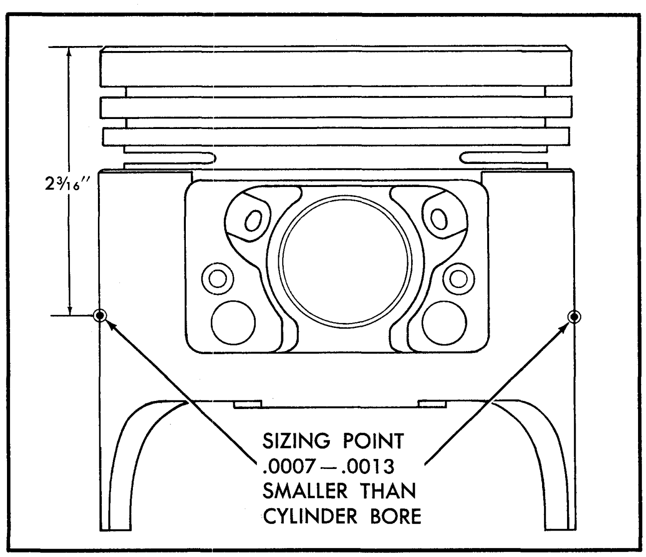



Fig. 6-144 Piston Sizing Points

size up to .030" oversize weigh exactly the same. Pontiac does not recommend boring beyond .010" during warranty period so that if necessary, engine can be serviced at high mileage without cylinder block replacement.

## FIT AND REPLACE PISTON

Pistons should be fitted in the bores by actually measuring the fit. Clearance between the piston and the cylinder bore should be .0007" to .0013".

If cylinder bores have been reconditioned, or if pistons are being replaced, reconditioning of bores and fitting of pistons should be closely coordinated.

If bore has been honed, it should be washed thoroughly with hot, soapy water and a stiff bristle brush.

Using a cylinder checking gauge, measure the cylinder bore crosswise of the block to find the smallest diameter. Record the smallest diameter of each bore.

*NOTE: When measuring cylinder bores and pistons it is very important that the block and pistons be at room temperature. If any or all of the parts are hotter or colder than normal room temperature, improper fitting will result.*

Measure the piston skirt perpendicular to the piston pin boss (piston pin removed) and at the sizing point indicated in Fig. 6-144.

Make sure the micrometer is in full contact (Fig. 6-145).

As the pistons are measured they should be marked for size identification and the measurements recorded.

If there is excessive clearance between a cylinder bore and the piston which was installed in that bore, a new piston should be used.

New pistons are serviced for both standard and premium fuel engines in standard size and .005", .010", .020" and .030" oversize.

*NOTE: Since these are nominal or basic sizes, it is important that new pistons be measured to ensure proper fit. All new pistons are serviced with selectively fitted piston pins.*

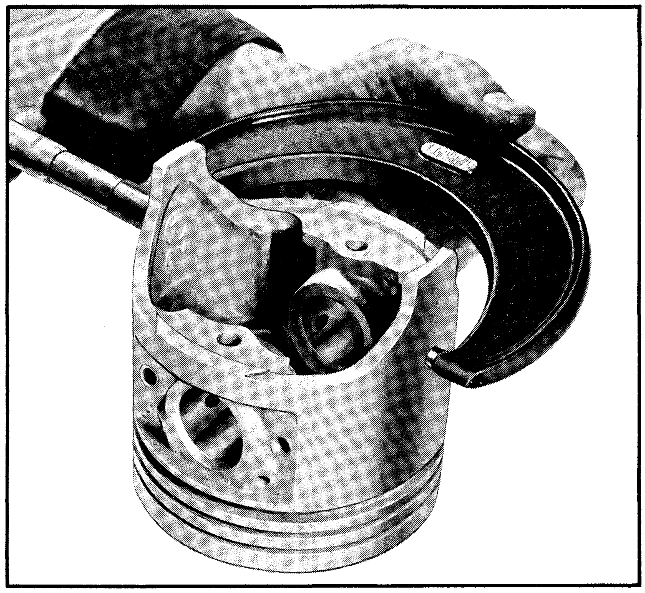


Fig. 6-145 Measuring Piston

After all measurements have been made, match the new pistons with the cylinders where they will fit with proper clearance. Honing of cylinder bore may be necessary to effect a proper fit. When properly mated, mark the pistons with the cylinder numbers they fit so they will not become mixed.

## FITTING PIN IN PISTONS

The piston pin fit in piston is .0003" to .0005" loose with pin and bosses clean and dry.

*NOTE: Piston and pin must be at room temperature when checking fit and pin must be able to fall from piston by its own weight.*

In case the standard size pin does not fit properly in the piston, an oversize piston pin must be fitted. Piston pins are available in .001" and .003" oversize.

When oversize pins are used, the piston pin bosses must be honed to give the required fit. It will also be necessary to hone the connecting rod pin bore to fit the oversize pin using a Sunnen hone or similar accurate equipment.

*NOTE: A special grit hone is used for honing the connecting rod pin bore. The piston pin size should be .0008" to .0016" larger than the connecting rod pin bore for the proper press fit. The piston pin should not show any movement under 1500 lb. minimum load after assembly in rod.*

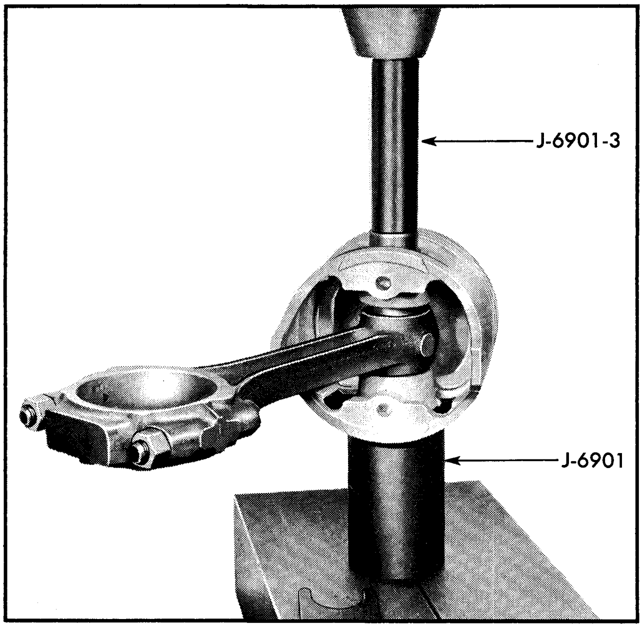



Fig. 6-146 Installation of Piston Pin

ASSEMBLE CONNECTING ROD TO PISTON

There is a notch cast in the top of all piston heads to facilitate proper installation. The piston assemblies should always be installed with the notch toward the front of the engine.

1. Place pilot plunger J-6901-6 and spring in the support base to be used as a pilot end stop. Use base support J-6901-8.

2. Place pilot plunger of tool J-6901 in piston pin bore and place on arbor press.

3. Coat piston pin and rod lightly with graphite lubricant.

4. Place tool J-6901-3 in piston pin and press pin into piston and connecting rod (Fig. 6-146) until piston pin bottoms against plunger of tool J-6901. Piston must turn freely on pin. If piston binds on pin, disassemble, hone piston pin bosses slightly and reassemble.

The odd numbered piston assemblies will always be installed in the left hand bank of cylinders, while the even numbered piston assemblies will always be installed in the right hand bank of cylinders.

One side of the connecting rod will have small identifying bosses (Fig. 6-147). The small identifying bosses on odd numbered rods will always be facing the rear of the engine, while the small identifying bosses on even numbered rods will be facing the front of the engine. When the rod and piston are correctly installed, the oil groove between the rod and cap will be on the left side on even numbered rods, and on the right side on odd numbered rods.

PISTON RINGS REPLACE

1. Remove oil pan.

2. Remove oil pump and baffle.

3. Remove intake manifold.

4. Remove cylinder heads.

5. Rotate crankshaft so crankpin carrying assembly to be replaced projects straight upwards.

6. Remove bearing cap and install connecting rod bolt guide set J-5239. Reinstall cap on connecting rod to ensure against subsequent mix of caps and connecting rod.

7. Carefully remove connecting rod and piston assembly by pushing out with narrow handle of ring guide (J-5239).

8. Clean carbon, varnish, and gum from piston surfaces, including underside of piston head. Clean ring grooves, and oil holes in oil ring groove, using suitable cleaning tools and solvent.

9. Carefully examine piston for rough or scored bearing surfaces; cracks in skirt or head; cracked,

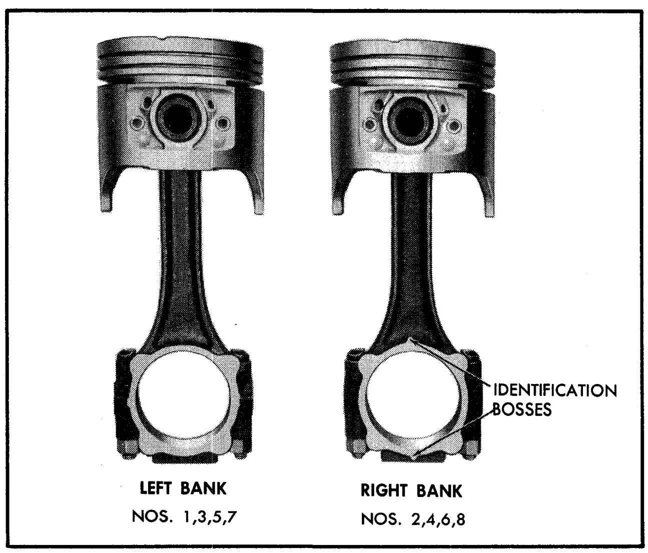



Fig. 6-147 Correct Assembly of Rod to Piston

broken, or worn ring lands; scored, galled, or worn piston bosses. Damaged or faulty pistons should be replaced.

10. Inspect bearing shells to see that they are serviceable. Fit of bearings should be checked when engine is being assembled.

Inspect cylinder bores for out-of-round or excessive taper. If bores show excessive out-of-round or taper, or if cylinder walls are badly scored, or worn beyond specified limits, the cylinder block should be rebored and new pistons and rings installed.

## PISTON RINGS - INSTALL ON PISTON

Two compression rings and one 3-piece oil control ring, all above the piston pin, are used on pistons for both standard and premium fuel engines. The top compression rings are taper faced and also have either a step or a chamfer on the inside diameter of the top side. The top compression ring is chrome plated. The lower compression ring may have a step or chamfer on the inside but should always be installed with the mark (letter "T", dot or word "TOP") toward the top.

New rings are serviced for the standard size pistons, and for .005", .010", .020", and .030" oversize pistons. When selecting rings be sure they match the size of the piston on which they are to be installed, i.e. standard rings for standard pistons, .010" oversize rings for .010" oversize pistons,

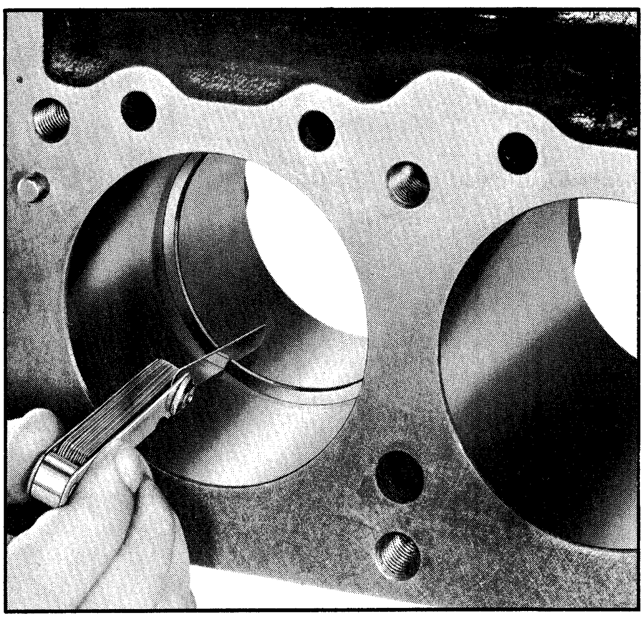


Fig. 6-148 Checking Ring Gap

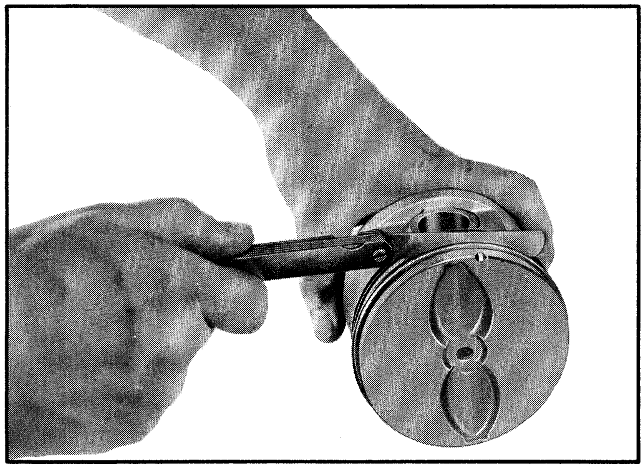


Fig. 6-149 Measuring Ring to Groove Side Clearance

etc. Ring gap and side clearance should be checked while installing rings as follows:

1. Check pistons to see that ring grooves and oil return holes have been properly cleaned.

2. Place ring down at the bottom of the ring traveled part of the cylinder bore in which it will be used. Square ring in bore by pushing it into position with head of piston.

3. Measure gap between ends of ring with feeler gauge (Fig. 6-148). Gaps should be as follows:

| | |
|---|---|
| Upper Compression Ring . . . . | .016" - .026" |
| Lower Compression Ring . . . . | .013" - .025" |
| Oil Ring . . . . . . . . . . . . . . . . | .015" - .055" |

Incorrect ring gap indicates that wrong size rings are being used. If rings are selected according to the size of the bore (standard .005" oversize, etc.) they should have the proper gap. It should not be necessary to alter ring gap by filing.

4. Install rings on piston, using suitable ring installing tool, such as J-7135, to prevent breakage or fracture of rings, or damage to pistons.

5. Measure side clearance of rings in ring groove (Fig. 6-149) as each ring is installed. Clearance with new pistons and rings should be as follows:

| | |
|---|---|
| Upper Compression Ring . . . . | .0015" - .0030" |
| Lower Compression Ring . . . . | .0015" - .0035" |
| Oil Control Ring . . . . . . . . . | .0005" - .0055" |

If side clearance is excessive, piston should be replaced.

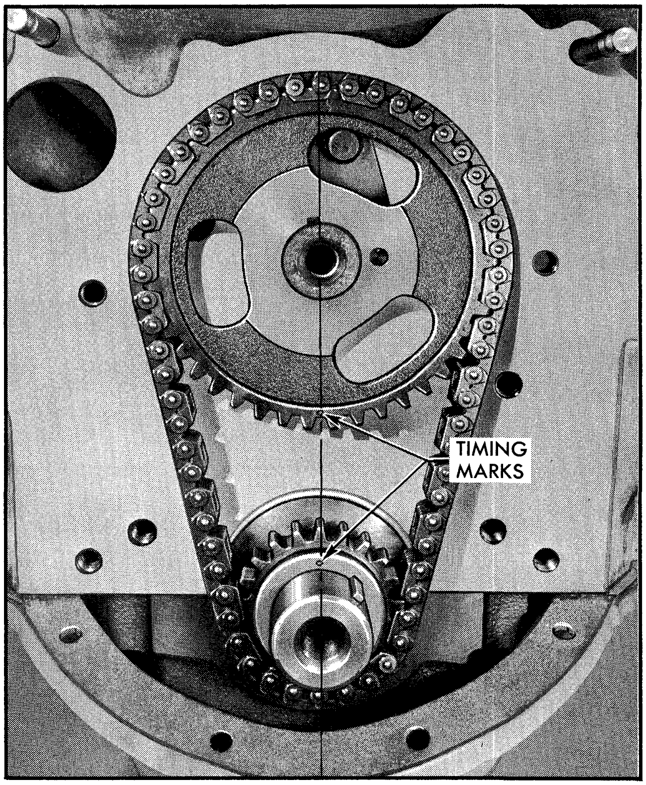



Fig. 6-150 Aligning Timing Marks

CONNECTING ROD AND PISTON ASSEMBLY-REPLACE

1. Install connecting rod bolt guide set on connecting rod bolts with long handle guide on same side as oil groove in rod.

2. Using suitable ring compressor insert piston and connecting rod assembly into cylinder so that notch in top of piston is toward front of engine.

3. From beneath engine, pull connecting rod, with bearing shell in place, into position against crankpin.

4. Remove guide set J-5239. Install bearing cap and cap nuts and tighten to 45 lb. ft. torque.

5. Replace oil pump and oil baffle, if they were removed.

6. Replace oil pan using new gaskets. Tighten oil pan screws to 15 lb. ft. torque.

7. Install cylinder head and intake manifold.

8. Install engine, clutch (SM) and transmission as an assembly.

9. Refill crankcase and cooling system, and check for leaks.

## CRANKSHAFT—REMOVE AND REPLACE

The crankshaft can be removed and replaced with cylinder heads, pistons, rods, manifolds and other upper engine components installed, but the flywheel, clutch and transmission assemblies must be removed.

REMOVE

1. Remove engine, clutch (SM) and transmission as an assembly.

2. Remove clutch (SM) and transmission from engine and install engine on suitable stand.

3. Remove spark plugs.

4. Remove engine oil pan.

5. Remove oil pump assembly and oil pump drive shaft (Fig. 6-127).

6. Remove oil baffle and oil baffle tube.

7. Remove harmonic balancer.

8. Remove fuel pump.

9. Remove timing chain cover, gasket and "O" ring seal.

10. Remove fuel pump eccentric and bushing (Fig. 6-119).

11. Remove sprockets and timing chain (Fig. 6-150).

12. Remove connecting rod caps.

*NOTE: Mark connecting rod caps for proper reinstallation.*

13. Remove main bearing caps from block.

*NOTE: Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Depress pistons until connecting rods are free of crankshaft.*

14. Lift crankshaft from block.

REPLACE

1. With upper bearings installed position crankshaft in block.

2. Install main bearing caps (with bearing shells in place) but do not tighten retaining bolts.

3. Pull connecting rods and piston assemblies into place, rotating crankshaft as necessary to properly seat rods.

*NOTE: Make sure upper bearings remain in proper position.*

4. Remove tape from connecting rod threads and install connecting rod caps (with bearings) and retaining nuts, but do not tighten.

5. Tighten rear main bearing cap to 110-130 lb. ft. torque and all remaining bearing caps 90-110 lb. ft. torque.

6. Tighten connecting rod bearing cap retaining nuts 40-46 lb. ft. torque.

7. Install sprockets and timing chain, making sure timing marks on sprockets are aligned properly (Fig. 6-150).

8. Install fuel pump eccentric and bushing and insert sprocket retaining bolt with washer. Tighten securely.

9. Install timing chain cover, new cover gasket and new "O" ring seal.

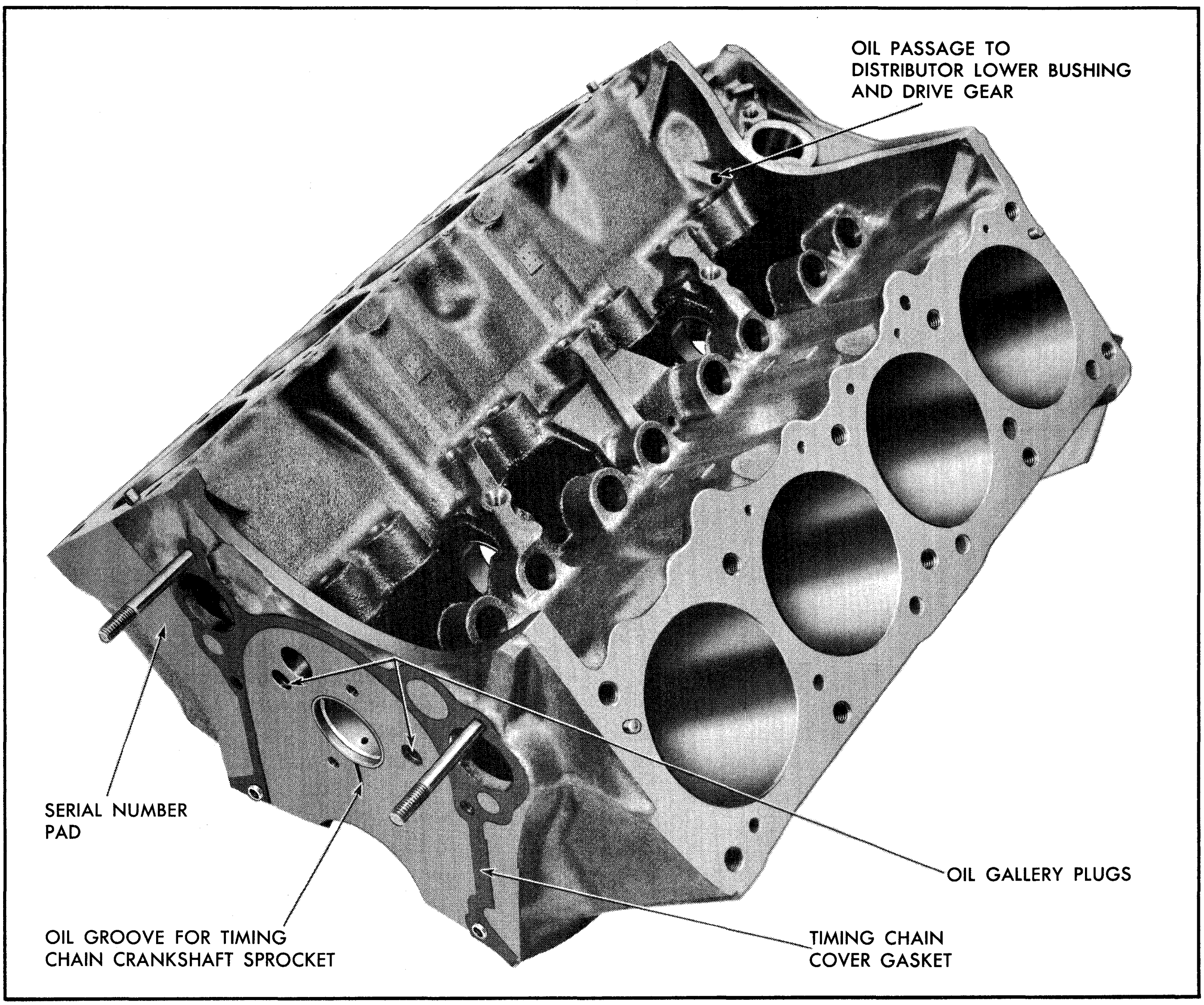



Fig. 6-151 Cylinder Block View from Left Front

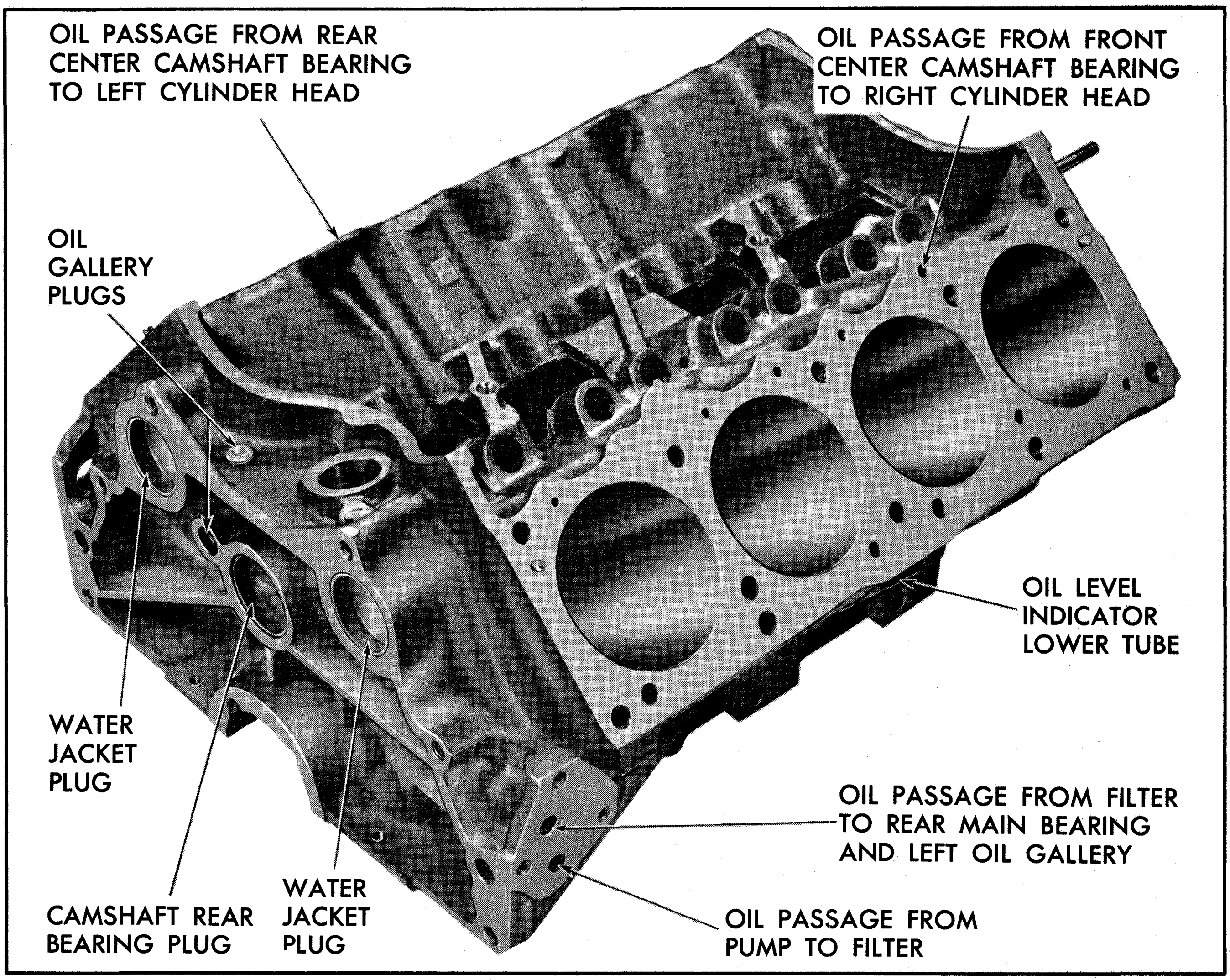



Fig. 6-152 Cylinder Block - View From Right Rear

10. Install fuel pump.

11. Install harmonic balancer.

12. Install oil baffle and oil baffle tube.

13. Install oil pump drive shaft and oil pump assembly.

14. Install engine oil pan.

15. Install spark plugs.

16. Remove engine from stand and install clutch (SM) and transmission to engine.

17. Install complete assembly in vehicle.

***ENGINE BLOCK CORE HOLE PLUGS AND OIL PASSAGE PLUGS—INSPECT AND REPLACE***

Engine moving part failures may be caused by lack of proper lubrication. In such case it may be necessary to trace oil supply in the block to determine the area of obstruction. Oil pressure drop may be caused by leaking oil passage plugs. For these reasons the following procedures and block illustrations are provided.

*NOTE: Oil circulation diagram is provided in the engine lubrication section. Figures 6-151, 6-152 and 6-153 also show the various locations of water jacket core hole plugs.*

a. With cylinder block inverted, use pen light to see that passage from oil pump to filter is open (Fig. 6-153).

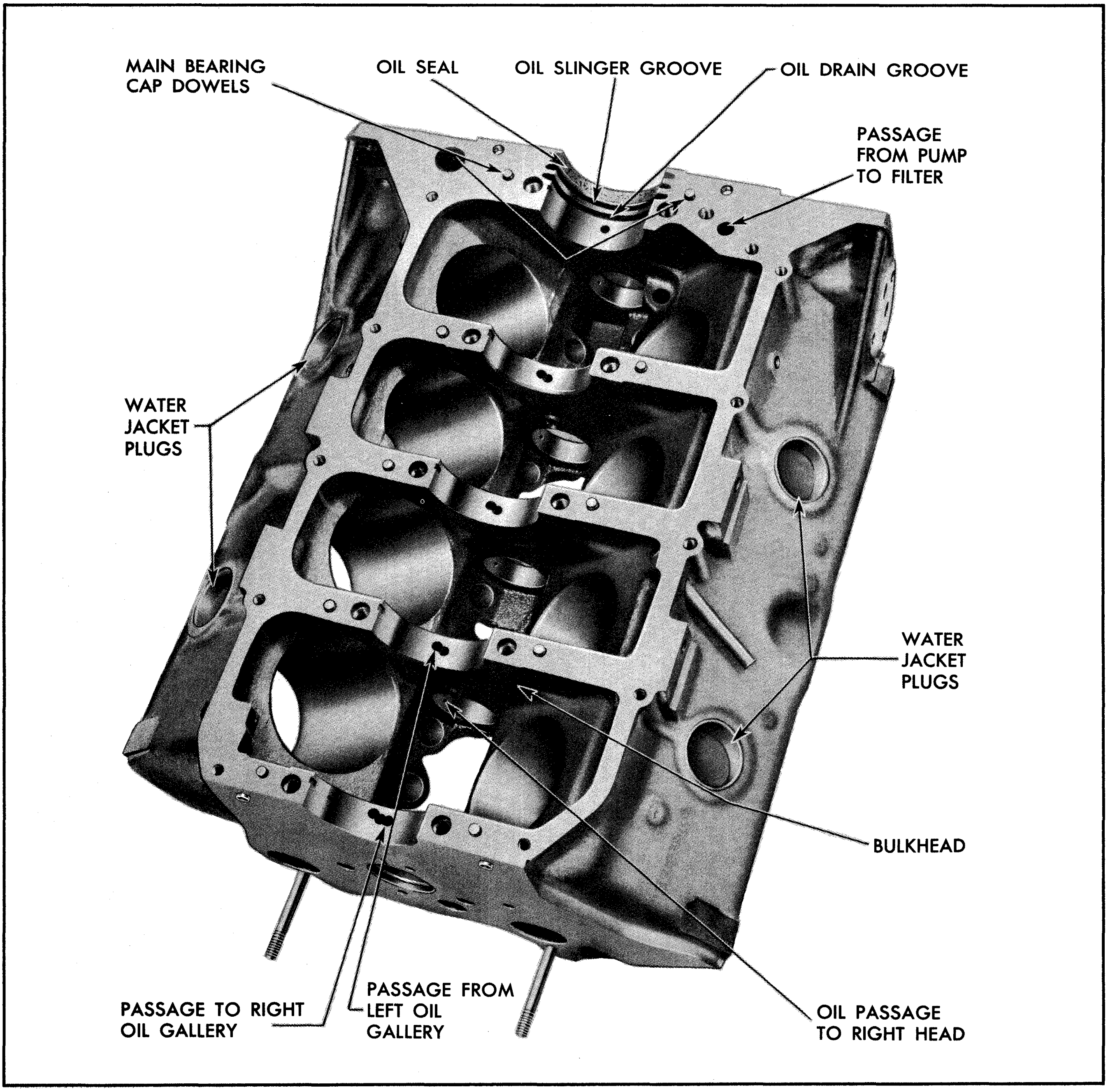



Fig. 6-153 Cylinder Block - View From Bottom

b. Check passage from filter outlet to rear main bearing by inserting wire in oil filter outlet passage and using pen light to see that wire is visible in passage to rear main bearing (Fig. 6-152).

c. Visually check passage from each main bearing to corresponding camshaft bearing (Fig. 6-153).

d. Check passage from filter outlet (through left oil gallery) to main bearings. Use rubber hose to blow smoke in oil filter outlet while observing to see that smoke passes out passages leading to all main bearings.

e. With cylinder block right side up, check oil passages to left bank lifter bosses. Use rubber hose to blow smoke in oil filter outlet while observing for smoke passing out oil passages from left main oil gallery to lifter bosses (Fig. 6-151).

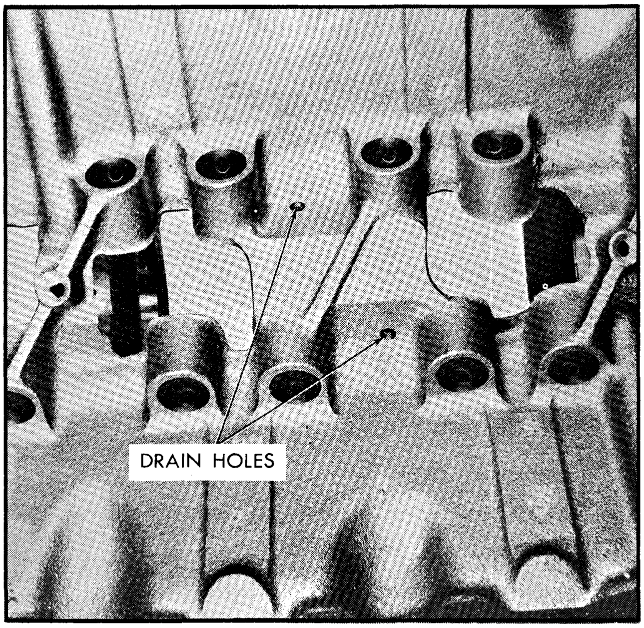



Fig. 6-154 Drain Holes in Lifter Gallery

f. Check oil passages to right bank lifter bosses. Use rubber hose to blow smoke in passage from front main bearing to right main oil gallery while observing for smoke passing out passages from right gallery to lifter bosses (Fig. 6-152).

g. Visually check passage from rear center camshaft bearing to left cylinder head and passage from front center camshaft bearing to right cylinder head (Fig. 6-152).

h. Use wire to check two drain holes in lifter gallery (Fig. 6-154).

INSTALL NEW PLUGS

The following plugs can be installed by driving into place using a flat piece of metal or hard wood bearing against the outer surface: Camshaft plug, water jacket plugs, rear oil gallery plug in block, cylinder head core hole plugs, valve spring chamber plug, and the oil hole plug in the top of the cylinder head.

Front oil gallery plugs in the block, and cylinder head oil gallery plugs must be driven into place using a tool which bears against the bottom of the plug. A 1/2" x 3" bolt will make a satisfactory tool for this purpose.

All plugs should be driven in until the outer edge is flush with the surrounding surface.

### *FITTED BLOCK ASSEMBLY—REPLACE*

Fitted block contains pistons, rings, pins, camshaft bearings and main bearings.

DISASSEMBLE

1. Remove flywheel housing and clutch assembly.

2. Remove flywheel and mount engine in holding stand.

3. Remove motor mounts and linkage bracket.

4. Remove generator and mounting bracket.

5. Remove fuel pump.

6. Remove harmonic balancer.

7. Remove timing chain cover, fan and pulley. Remove timing cover mounting studs.

8. Remove fuel pump eccentric and bushing.

9. Slide timing chain and sprockets off end of camshaft and crankshaft.

10. Remove camshaft thrust plate.

11. Remove distributor and high tension wires.

12. Remove coil.

13. Remove starter assembly.

14. Remove intake manifold.

15. Remove push rod cover.

16. Remove oil level indicator.

17. Remove rocker arm covers.

18. Loosen rocker arm nuts, rotate rocker arms and remove push rods. Store push rods so that they may be reinstalled in the same position as removed.

19. Remove cylinder heads and exhaust manifolds.

20. Remove cylinder head gaskets.

21. Remove oil filter assembly.

22. Remove valve lifters; use J-3049 if necessary.

Place valve lifters in storage box J-5763 so lifters can be reinstalled in original location.

23. Remove camshaft.

24. Invert engine and remove oil pan and flywheel front cover.

25. Remove oil pump assembly and drive shaft.

26. Remove baffle and oil indicator tube extension.

27. Remove crankshaft.

28. Remove all connecting rod and piston assemblies.

29. Remove connecting rods from pistons and identify for installation in original location.

30. Remove old block from stand and mount new fitted block on stand.

31. Remove each piston and pin assembly from new block and identify for installation in original position.

This completes disassembly for fitted block replacement. Proceed with assembly operations. Use new gaskets throughout and pay special attention to torque requirements.

ASSEMBLE

1. Install old connecting rods to proper piston and pin assemblies and install in cylinder from which pistons were removed.

2. Install crankshaft.

*NOTE: New block has fitted upper main bearings and standard size lower main bearings. It is necessary to check main bearing to crankshaft clearance using Plastigage to be sure main bearings do not allow excessive clearance with the old crankshaft. Replace main bearings with undersize bearings if necessary.*

3. Install two timing cover mounting studs.

4. Install camshaft using care not to damage bearings.

5. Install camshaft thrust plate indexing oiling slot in plate with oil groove in block.

6. Make sure keys are in place in crankshaft and camshaft. Install timing chain and sprockets making sure marks in sprockets are aligned exactly on a straight line passing through the shaft centers. Alignment can be simplified by first installing sprockets without chain to align timing marks. If timing chain is excessively loose, new chain or new chain and sprockets should be used.

7. Position fuel pump eccentric bushing over eccentric with flange toward camshaft sprocket.

8. Install fuel pump eccentric and bushing on camshaft sprocket, indexing tang on eccentric with keyway cutout in camshaft sprocket.

9. Position timing cover gasket over mounting studs and dowels on block.

10. Install timing cover, water pump, fan and pulley. Do not install stud nuts at this time.

11. Slide harmonic balancer onto crankshaft, and install harmonic balancer to crankshaft bolt and washer. Place hammer handle between block and crankshaft counterweight to keep crankshaft from turning and tighten harmonic balancer to crankshaft bolt 160 lb. ft. torque.

12. Install baffle and oil indicator tube extension.

13. Insert oil pump drive shaft with dimpled end towards block.

14. Install oil pump and gasket.

15. Cement new gaskets to oil pan and rear main bearing cap; use retainers to hold gasket. Install oil pan except for two rear screws. Position flywheel housing front shield and gasket against oil pan and install two rear oil pan bolts.

16. Position new cylinder head gaskets on block.

17. Position cylinder heads and exhaust manifolds on locating pins. Install head bolts and torque to 95 lb. ft.

*NOTE: Three different length bolts are used. When inserted on proper holes, all will project an equal amount from their respective bosses.*

18. Install lifters in bosses from which they were removed.

19. Install push rods in same location as originally removed and with same end facing valve lifter.

20. Tighten rocket arm ball retaining nuts to 15-25 lb. ft. torque.

21. Install distributor as follows:

a. Turn crankshaft to firing position of number one cylinder (number one exhaust and intake valve lifters both on base circles of their cams and timing mark on harmonic balancer indexed with pointer). NOTE: Number one intake must have just closed.

b. Position new distributor to block gasket on block.

c. Install distributor (without cap and wires) so that vacuum diaphragm faces the left side of the engine and rotor arm points toward contact in cap for number one cylinder. It will also be necessary to turn the oil pump drive shaft so it will index with distributor shaft.

22. Install distributor hold down clamp and special bolt and tighten enough to hold distributor in place.

23. Install coil.

24. Cement new gaskets to push rod covers. Install push rod covers with screws and flat washers and tighten to 5 lb. ft. torque.

25. Cement new gaskets to rocker arm cover and install cover.

26. Install intake manifold gasket with plastic locating sleeves in cylinder head as shown in Fig. 6-22.

27. Start intake manifold to timing cover draw bolt into intake manifold.

28. Position intake manifold and install retaining screws finger tight.

29. Tighten draw bolt to 10-20 lb. ft. torque to obtain metal to metal contact between manifold and timing cover.

30. Tighten manifold screws to 40 lb. ft. torque.

31. Install oil filter assembly and gasket.

32. Install oil level indicator.

33. Install throttle linkage.

34. Install starter assembly.

35. Install fuel pump.

36. Install generator and bracket.

37. Install fan belt and adjust belt tension as covered in Section 6A.

## SPECIFICATIONS—6 CYL. ENGINE

### GENERAL

| | |
|---|---|
| Type | In Line 6 |
| Bore and Stroke | 3-3/4 x 3-1/4 |
| Piston Displacement | 215 cu. in. |
| Taxable Horsepower | 33.75 |
| Compression Ratio | 8.6:1 |
| Horsepower | 140 @ 4200 rpm |
| Torque | 206 @ 2000 |
| Compression Pressure at Cranking Speed (with throttle open) | 140 psi |
| Firing Order | 1-5-3-6-2-4 |
| Production Engine No. | Pad at Right Front Side by Distributor Shaft Hole |
| Cylinder Nos. — Front to Rear | 1-2-3-4-5-6 |

### CAMSHAFT

| | |
|---|---|
| Material | Alloy Cast Iron |
| Journal Diameter | 1.8687" |
| Bearing —Outside Diameter | 2.014"-2.016" |
| Bearing Length | .860" |
| Bearing Clearance | .0015"-.0030" |
| End Play | .001"-.005" |

### CONNECTING RODS

| | |
|---|---|
| Material | Forged Steel |
| Length, center to center | 5.70" |
| Bearing Clearance on Crankpin—Limits When New | .0005"-.0025" |
| End Play of Connecting Rod on Crankpin | .008"-.014" |

### CRANKSHAFTS

| | |
|---|---|
| Material | Cast Nodular Iron |
| Journal Diameter | 2.30" |
| Bearing Length — Bearing Shell, Including Chamfer | |
| 1-2-3-4-5-6 | .80" |
| 7 | .101" |
| Thrust Taken On | 7 |
| Crankpin Diameter | 2.00" |
| Journal Maximum Out of Round and Taper | .0002" |
| Pin Maximum Out of Round (New) | .0002" |
| Pin Maximum Taper (New) | .0003" |
| End Play — Limits When New | .002"-.006" |
| Main Bearing Clearance — Limits When New | .0005"-.002" |

### FLYWHEEL

| | |
|---|---|
| Teeth on Ring | |
| Teeth on Starter Pinion | |

### PISTONS AND CYLINDERS

| | |
|---|---|
| Cylinder Bore Out-of-Round and Taper When New | .001" |
| Piston Material | Aluminum Alloy |
| Piston Clearance in Cylinder — | .0005"-.0011" |
| Piston Ring Gap | |
| Compression Rings | .010"-.020" |
| Oil Ring Segments | .015"-.055" |
| Piston Ring to Groove Clearance | |
| Compression Rings | |
| Upper | .0015"-.0030" |
| Lower | .0015"-.0035" |
| Oil Ring Assembly | .0005"-.0055" |

### PISTON PINS

| | |
|---|---|
| Fit in Piston | .0003"-.0005" loose with piston and pin at 70°F. |
| Fit in Rod | .0008"-.0016" |
| Diameter (Selective) | .9272" |
| Length | 3.00" |

### TIMING GEARS

| | |
|---|---|
| Camshaft Gear Material | Bakelite and Fabric Composition with Steel Hub |
| Crankshaft Gear Material | Steel |

### VALVES

| | |
|---|---|
| Material | |
| Intake | 1041 Steel |
| Exhaust | 21-4N Steel |

### VALVES (CON'T.)

| | |
|---|---|
| Head Diameter | |
| Intake | 1.715"-1.725" |
| Exhaust | 1.495"-1.505" |
| Stem Diameter | |
| Intake | .3410"-.3417" |
| Exhaust | .3410"-.3417" |
| Seat Angle | |
| Intake | 46° |
| Exhaust | 46° |
| Fit of Stem in Guide (New) | Intake .0010"-.0027" — Exhaust .0020"-.0037" |
| Valve Lift (Measured at Stem) | .335 |

### VALVE LIFTER

| | |
|---|---|
| Leak Down Rate | 12-60 seconds with 50 lbs. load |
| Plunger Travel | .094 |

### VALVE SPRING

| | |
|---|---|
| Spring Pressure and Length | 84-92 lbs. @ 1.660" — 163-173 lbs. @ 1.330" |

## 6 CYL. ENGINE
## WRENCH TORQUE SPECIFICATIONS

*NOTE: Torque in lb. ft. unless otherwise shown.*

| TORQUE | SIZE | APPLICATION |
|---|---|---|
| | | CYLINDER BLOCK - BEARINGS & CAPS |
| 60-70 | 7/16-14 | Bolt - Main Bearing Cap to Block |
| 60-70 | 7/16-14 | Stud - #6 Main Brg. Cap to Block |
| | | CYLINDER HEAD |
| 85-100 | 1/2-13 | Bolt - Cylinder Head |
| | | FLYWHEEL |
| 55-65 | 7/16-20 | Bolt - Flywheel Assy. to Crankshaft Auto Trans. |
| 20-35 | 3/8-16 | Bolt - Cover Plate Assy. to Flywheel |
| 60-75 | 7/16-20 | Bolt - Flywheel Assy. to Crankshaft SMT |
| | | CONNECTING RODS - PISTONS - RINGS |
| 30-35 | 11/32.24 | Nut - Connecting Rod & Bushing Assy. Cap to Rod |
| | | OIL PAN |
| 5-8 | 1/4-20 | Bolt - Oil Pan to Cylinder Block |
| 8-15 | 5/16-18 | Bolt - Oil Pan to Cylinder Block (Also attaches Clutch Housing) Cover Shield) |
| 18-25 | 1/2-20 | Screw - Oil Pan Drain |
| | | OIL PRESSURE, PRESSURE REGULATOR & OIL SCREEN |
| 5-8 | 1/4-20 | Bolt - Engine Oil Pump Cover to Body |
| 10-20 | 5/16-18 | Bolt - Engine Oil Pump Assy. to Block |

## 6 CYL. ENGINE

| TORQUE | SIZE | APPLICATION |
|---|---|---|
| | | OIL PLUGS |
| * | 3/8-PTF | Plug - Cylinder Block Oil Gallery |
| 5-10 | 1/4-20 | Screw - Oil Pump & Screen Supp. to Oil Pump & Screen |
| 20-35 | 3/8-16 | Nut - Oil Pump & Screen Supp. to #6 Crankshaft Bearing Stud |
| | | OIL FILTER |
| | | CRANKCASE FRONT END COVER |
| 5-8 | 1/4-20 | Screw & L/W Assy. - C/Case Frt. End Cover to Cylinder Block |
| | | ENGINE FAN & PULLEY |
| 15-25 | 5/16-24 | Bolt - Fan & Pulley to Water Pump Hub |
| | | WATER PUMP |
| 10-25 | 5/16-18 | Bolt - Water Pump to Cylinder Block |
| | | THERMOSTAT & WATER OUTLET FITTING |
| 20-35 | 3/8-16 | Bolt - Water Outlet Fitting to Manifold |
| 20-35 | 3/8-16 | Bolt - Thermostat Housing to Water Outlet Fitting |
| | | MANIFOLD - INTAKE & EXHAUST |
| 25-40 | 3/8-24 | Nut - Intake & Exhaust Manifold Clamp |
| 25-40 | 3/8-16 | Bolt - Intake & Exhaust Manifold Clamp |
| 20-35 | 3/8-16 | Bolt - Exhaust Manifold to Intake Manifold |
| 15-25 | 3/8-16 | Bolt - Intake & Exhaust Manifold Clamp (at end Exh. Port) |
| | | CARBURETOR & AUTO CHOKE |
| 20-35 | 3/8-24 | Nut - Carburetor to Manifold (Stud) |
| 5-8 | 1/4-20 | Screw & L/W - Choke Heat Plate to Manifold |
| | | CARBURETOR AIR CLEANER & SILENCER |
| 10-20 lb. in. | 1/4-20-PC | Stud - Air Cleaner & Silencer to Carburetor |
| 10-20 lb. in. | 1/4-20-PC | Nut - Air Cleaner & Silencer to Carburetor |
| | | FUEL PUMP & PIPES |
| 10-25 | | Screw & L/W Fuel Pump to Cylinder Block |
| * | | Fitting - Fuel Pump Fuel Hose to Carburetor & Pump |
| | | ACCELERATOR CONTROL |
| 10-25 | 5/16-18 | Stud - Accelerator Control Lever to Manifold |
| 60-120 lb. in. | 1/4-28 | Stud - Accelerator Pedal Pivot Ball |
| 25-45 lb. in. | #12-28-PC | Screw & L/W Accelerator Pull Back Spring Bracket to Carburetor |
| 55-65 lb. in. | 1/4-14-PC | Screw - Accelerator Pedal Rod Supp. to Dash |

*Torque not a requirement, other means of control and/or specifications used, checked for alignment, bottoming, height and/or leaks.

## 6 CYL. ENGINE

| TORQUE | SIZE | APPLICATION |
|---|---|---|
| | | ENGINE TO FRAME MOUNTING |
| | 3/8-16-PC | Bolt - Engine Mounting Engine Bracket to Cylinder Block |
| | 3/8-16-PC | Bolt - Engine Mounting Frame Bracket to Cross Member |
| | 7/16-14-PC | Bolt - Engine Mounting Assy. to Frame Bracket |
| | 7/16-20 | Bolt - Engine Mounting Assy. to Engine Mounting Engine Bracket |
| | 7/16-14-PC | Bolt - Trans. Supp. Mounting Assy. to Trans. |
| | 3/8-16-PC | Bolt - Engine Rear Cross Member Insulator Retainer to Frame |
| | 7/16-20 | Bolt - Engine Mounting Assy. to Engine Mounting Engine Brackets |
| | 3/8-16-PC | Bolt - Engine Mounting RH & LH Brackets to Cylinder Block |
| | 3/8-16-PC | Bolt - Engine Mounting Frame RH & LH Bracket to Cross Member |
| | 7/16-14-PC | Bolt - Mounting Assy. to Frame Bracket |
| | 7/16-14-PC | Bolt - Trans. Supp. Mounting Assy. to Cross Member |
| | | CAMSHAFT & DRIVE, VALVE & VALVE COVERS |
| 6-10 lb. in. | 5/16-18 | Bolt - Valve Push Rod Cover Assy. to Block |
| 5-8 | 1/4-20 | Bolt L/W - Camshaft & Gear Assy. to Cylinder Block |
| | | VALVE ROCKER ARM & COVERS |
| 25-50 lb. in. | 1/4-20 | Bolt - Valve Rocker Arm Cover to Head |
| 55-124 lb. in. | 3/8-24 | Nut - Valve Rocker Arm Ball Adjusting |
| | | DISTRIBUTOR |
| 8-12 | 3/8-16 | Bolt - Distributor Hold-Down Clamp to Cylinder Block |
| * | 3/16 (Tube) | Nut - Distributor to Carburetor Vacuum Control |
| * | 1/8 NPTF | Plug - Distributor Intake Manifold Vacuum Hole |
| | | IGNITION SWITCH, COIL, WIRES & SPARK PLUGS |
| | | Bolt - Ignition Coil Bracket |
| | | Ferrule - Ignition & Starter Sw to Instrument Panel |
| 15-25 | 1/4MM | Plug Assembly - Spark |
| | | GEARSHIFT LEVER & PARTS |
| 10-20 | 5/16-18 | Bolt & Nut - Trans. Shifter Levers to Shafts |
| 8-12 | 3/8-16 | Nut - Trans. Control Lever to 1st & Rev. Shift Rod |
| 8-12 | 3/8-16 | Nut - Trans. Control Idler Lever to 2nd & 3rd Shift Rod |
| | | CLUTCH HOUSING & COVER |
| 5-8 | 1/4-20 | Screw & L/W - Clutch Housing Cover to Cylinder Block |
| | | Bolt - Clutch Fork Ball to Clutch Housing |
| | | CLUTCH CONTROL |
| 30-45 | 7/16-20 | Bolt - Clutch Fork Ball to Flywheel Housing |
| 8-12 | 3/8-16 | Nut - Clutch Fork Rod Assy. Adj. Jam |
| 25-35 | 3/8-24 | Nut - Clutch Cont. Shaft Stud to Mounting Bracket on Side Rail |
| | | Screw - Clutch Cont. Rod Bellows Retainer to Floor Pan |
| | | Bolt - Clutch Release Brg. Supp. Retainer |
| 25-30 | 1/2-13 | Stud - Clutch Cont. Shaft Stud Assy. to Cylinder Block |
| | | Bolt - Cover & Pressure Plate Assy. to C/Shaft |
| | | MUFFLER - EXHAUST PIPE - TAIL PIPE |
| 15-20 | 5/16-18 | Nut - Exhaust Pipe to Muffler U-Bolt |
| 15-20 | 5/16-18 | Nut - Tail Pipe to Muffler U-Bolt |
| 10-15 | 5/16-18 | Screw - Muffler Tail Pipe Hanger to Frame |
| 10-15 | 5/16-18 | Screw - Tail Pipe Hanger to Frame |
| 6-9 | 20-9 | Screw - Tail Pipe Clamp to Hanger Assy. |
| 14-18 | 3/8-16 | Nut - Exhaust Pipe Manifold Stud (6-Cylinder Engine) |

*Torque not requirement, other means of control and/or specifications used, checked for alignment, bottoming, height and/or leaks.

## SPECIFICATIONS—V-8 ENGINE

| | |
|---|---|
| Type | 90° V-8 O.H. Valve |
| Bore and Stroke | 3-23/32" x 3-3/4" |
| Taxable Horsepower (326) | 44.3 |
| (326 HO) | |
| Compression Ratio - 326 | 8.6:1 |
| Compression Ratio - 326 HO | 10.5:1 |

| | 326 SM 326 Auto. | 326 HO SM 326 HO Auto. |
|---|---|---|
| Horsepower | 250 @ 4600 rpm | 280 @ 4800 rpm |
| and Torque | 333 @ 2800 rpm | 355 @ 3200 rpm |

| | |
|---|---|
| Compression Pressure at Cranking Speed 8.6:1 Compression Ratio | 140-160 psi @ 155-165 rpm |
| Compression Pressure at Cranking Speed 10.5:1 Compression Ratio | 170-190 psi @ 155-165 rpm |
| Firing Order | 1-8-4-3-6-5-7-2 |
| Production Engine No. Location | Front Face of Right Cylinder Bank |
| Cylinder Nos.—Front to Rear | |
| Left Bank | 1-3-5-7 |
| Right Bank | 2-4-6-8 |

### CAMSHAFT

| | |
|---|---|
| Material | Alloy Cast Iron |
| Journal Diameter | 1.8987"-1.8997" |
| Bearing—Inside Diameter (after line reaming) | 1.9012"-1.9017" |
| Bearing Length | |
| Front | 1.060" |
| All Others | .680" |
| Bearing Clearance | .0015" to .0030" |
| End Play | .003"-.007" |

### CONNECTING RODS

| | |
|---|---|
| Material | Arma Steel |
| Length, center to center | 6.625" |
| Bearing Length | .88" |
| Bearing clearance on crank pin—limits when new | .0005"-.0025" |
| End play of connecting rod on crank pin | .006" to .011" |

### CRANKSHAFT

| | |
|---|---|
| Material | Pearlitic Malleable Iron |
| Journal Diameter | 3.000" |
| Bearing Length—bearing shell, including chamfer | |
| Front | .94" |
| Front Center | .94" |
| Center | .94" |
| Rear Center Including Thrust Flanges | 1.13" |
| Rear | 1.59" |
| Thrust Taken On | Rear Center |
| Crank Pin Diameter | 2.25" |
| Journal and Pin Maximum Out of Round and Taper | .00025" |
| Thrust Bearing End Play—Limits When New | .0035"-.0085" |
| Main Bearing Clearance—Limits When New | .0005"-.0020" |

### FLYWHEEL

| | |
|---|---|
| Teeth on ring | 166 |
| Teeth on starter pinion | 9 |

### PISTONS AND CYLINDERS

Cylinder bore out-of-round and taper when new . . . . . .001"
Piston material . . . . . . Tin Plated Aluminum Alloy
Piston clearance in cylinder-Standard . . . . . .0007" to .0013"
Piston ring gap
  Compression rings
    Upper . . . . . . .016"-.026"
    Lower . . . . . . .013"-.025"
  Oil Ring Segments . . . . . . .015"-.055"
Piston ring to groove clearance
  Compression rings
    Upper . . . . . . .0015" to .0030"
    Lower . . . . . . .0015" to .0035"
  Oil Ring Assembly . . . . . . .0005" to .0055"

### PISTON PINS

Fit in piston . . . . . . .0003" to .0005" loose with piston and pin at 70° F.
Fit in rod . . . . . . .0008" to .0016" press
Diameter (selective) . . . . . . .9800" to .9804"
Length . . . . . . 3.250"

### TIMING CHAIN

Camshaft sprocket material . . . . . . Cyanide hardened cast iron (cylinder iron)
Crankshaft sprocket material . . . . . . Case hardened steel—SAE 1020 or 1022
Number of links in chain . . . . . . 60

### VALVES

Material
  Intake . . . . . . 1041 Steel
  Exhaust . . . . . . GM T-XCR Steel
Head Diameter
  Intake . . . . . . 1.88"
  Exhaust . . . . . . 1.60"
Stem Diameter
  Intake . . . . . . .3407"-.3414"
  Exhaust . . . . . . .3402"-.3409"
Seat Angle
  Intake . . . . . . 30°
  Exhaust . . . . . . 45°
Fit of stem in guide (new) . . . . . . Intake .0021" to .0038"
Exhaust .0026" to .0043"
Valve Lift . . . . . . .365"-.373"

### VALVE LIFTER

Diameter . . . . . . .8424" to .8427"
Clearance in boss . . . . . . .0013" to .0028"
Length-overall . . . . . . 2.000"
Leak-down rate . . . . . . 12-60 seconds with 50 lb. load
Plunger travel (for gauging purposes) . . . . . . .125 (1/8")

### VALVE SPRINGS

| | 326 | | 326 H.O. | |
|---|---|---|---|---|
| | Pressure | Length | Pressure | Length |
| Outer | | | | |
| Valve Opened | 106-112 lbs. | @ 1.15" | 117-127 lbs. | @ 1.17" |
| Valve Closed | 55-61 lbs. | @ 1.53" | 56-62 lbs. | @ 1.53" |
| Inner | | | | |
| Valve Opened | 59-65 lbs. | @ 1.10" | 94-100 lbs. | @ 1.107" |
| Valve Closed | 24-30 lbs. | @ 1.47" | 30-36 lbs. | @ 1.48" |

## V-8 ENGINE
## WRENCH TORQUE SPECIFICATIONS

| TORQUE | SIZE | APPLICATION |
|---|---|---|
| | | CYLINDER BLOCK |
| 90-110 | 1/2-13 | Bolt - Crankshaft Bearing Cap (Exc. Rear Main) |
| 110-130 | 9/16-12 | Bolt - Crankshaft Bearing Cap (Rear Main) |
| | | CYLINDER HEAD |
| 85-100 | 1/2-13 | Bolt - Cylinder Head |
| | | HARMONIC BALANCER |
| 15-25 | 5/16-24 | Bolt - Weight to Balancer |
| 130-190 | 5/8-16 | Bolt - Balancer Assy. to Crankshaft |
| | | FLYWHEEL |
| 85-100 | 1/2-20 | Bolt - Flywheel Assy. to Crankshaft |
| | | CONNECTING RODS, PISTONS & RINGS |
| 40-46 | 3/8-24 | Nut - Connecting Rod & Bearing Assy. Cap to Rod |
| | | OIL PAN |
| 10-20 | 5/16-18 | Bolt - Engine Oil Baffle to Bearing Caps |
| 18-25 | 1/2-20 | Plug - Oil Pan Drain |
| 8-15 | 5/16-18 | Bolt - Oil Pan Assy. to Cylinder Block |
| 10-20 | 5/16-18 | Bolt - Oil Pan to Cylinder Block (also attach Oil Pan Reinf.) |
| | | OIL PUMP |
| 10-20 | 5/16-18 | Bolt - Oil Pump Cover to Body |
| 20-35 | 3/8-16 | Bolt - Oil Pump to Cylinder Block |
| | | OIL PLUGS |
| * | 3/8 PTF | Plug - Cylinder Block Oil Gallery |
| | | OIL FILTER |
| 20-35 | 3/8-16 | Bolt - Oil Filter to Cylinder Block |
| | | CRANKCASE VENTILATION |
| 30-45 | 3/8-16 | Bolt - Crankcase Vent. Hose Brkt. to Intake Manifold |
| | | TIMING CHAIN COVER |
| 10-20 | 5/16-18 | Bolt - Timing Chain Cover to Intake Manifold Clamp |
| 20-35 | 3/8-16 | Bolt - Timing Chain Cover to Cylinder Block |
| * | 3/8-24 | Stud - Timing Chain Cover to Block (Block End) |
| 20-35 | 3/8-16 | Nut - Timing Chain to Block (Stud) |
| | | ENGINE FAN & PULLEY |
| 15-25 | 5/16-24 | Bolt - Fan Assembly to W/P Shaft Flange |
| | | WATER PUMP |
| 10-25 | 5/16-18 | Bolt - Pump Assy. to Timing Chain Cover |
| * | 5/16-24 | Stud - Pump Assy. to Timing Chain Cover |
| 10-25 | 5/16-24 | Nut - Pump Assy. to Timing Chain Cover Stud |

*Torque not a requirement, other means of control and/or specifications used, checked for alignment, bottoming, height and/or leaks.

## V-8 ENGINE

| TORQUE | SIZE | APPLICATION |
|---|---|---|
| | | THERMOSTAT & WATER OUTLET |
| 20-35 | 3/8-16 | Bolt - Water Outlet Fitting to Intake Manifold |
| | | MANIFOLDS |
| 30-45 | 3/8-16 | Bolt - Exhaust Manifold to RH Head |
| 30-45 | 3/8-16 | Bolt - Exhaust Manifold to LH Head |
| 20-35 | 3/8-16 | Bolt - Intake Manifold to Cylinder Head |
| | | CARBURETOR & AUTO CHOKE |
| 10-25 | 5/16-18 | Bolt - Carburetor to Manifold |
| 10-25 | 5/16-18 | Bolt - Choke Heat Tube & Plate to Manifold |
| * | 1/4 Tube | Nut - Carburetor to Manifold Tube to Carburetor |
| | | AIR CLEANER & SILENCER |
| 10-20 lb. in. | 1/4-20 | Stud - Air Cleaner to Carburetor |
| 10-20 lb. in. | 1/4-20 | Nut - Air Cleaner & Silencer to Carburetor |
| | | FUEL FILTER, PUMP & PIPES |
| 5-15 lb. in. | 10-12-PC | Screw - Fuel Filter to Carburetor Pipe Hose Bracket to Hose |
| * | 3/8-16 | Nut - Pipe Assy. Fuel Pump & Filter to Carburetor |
| 15-30 | 3/8-16 | Bolt - Fuel Pump to Timing Chain Cover |
| | | ACCELERATOR & THROTTLE CONTROLS |
| 60-120 lb. in. | 1/4-28-PC | Bolt - Throttle Return Check Diaphragm |
| 60-120 lb. in. | 1/4-28-PC | Bolt - Carburetor Lever Ext. to Carburetor Lever |
| 55-65 lb. in | 1/4-14-PC | Accelerator Pedal Lever Supp. Assy. to Dash |
| 55-65 lb. in. | 1/4-14-PC | Throttle Control Cable to Dash |
| 60-120 lb. in. | 1/4-28-PC | Throttle Control Cable Clamp to Bracket |
| 60-120 lb. in. | 1/4-28 | Stud - Accelerator Pedal Pivot Ball |
| | | ENGINE TO CROSS MEMBER MOUNTING |
| | 7/16-14-PC | Bolt - Engine Front Mounting Bracket to Cylinder Block |
| | 7/16-14-PC | Bolt - Engine Front Mounting Insulator to Supp. Bracket |
| | | CAMSHAFT & DRIVE, VALVES & COVERS |
| 25-70 lb. in. | 5/16-18 | Bolt - Valve Push Rod Cover to Cylinder Block |
| 10-25 | 5/16-18 | Bolt - Camshaft Thrust Plate to Cylinder Block |
| 30-45 | 1/2-20 | Bolt - Camshaft Sprocket to Camshaft |
| | | VALVE ROCKER ARMS & COVERS |
| 45-80 lb. in. | 5/16-18 | Bolt - Valve Rocker Arm Cover to Head |
| 15-25 | 3/8-24 | Nut - Valve Rocker Arm Ball Retainer |
| | | AIR CLEANER & SILENCER |
| 10-20 lb. in. | 1/4-20-PC | Stud - Air Cleaner & Silencer to Carburetor |
| 10-20 lb. in. | 1/4-20-PC | Nut - Air Cleaner & Silencer to Carburetor |
| | | FUEL FILTER PUMP & PIPES |
| 5-15 lb. in. | 10-12 | Screw - Fuel Filter Assy. to Bracket A/C Only |

*Torque not a requirement, other means of control and/or specifications used, check for alignment, bottoming, height and/or leaks.

## V-8 ENGINE

| TORQUE | SIZE | APPLICATION |
|---|---|---|
| | | ENGINE TO FRAME MOUNTING |
| | 7/16-14-PC | Bolt - Engine Frt. Mounting Bracket to Cylinder Block |
| | 7/16-14-PC | Bolt - Engine Frt. Mounting Insulator to Supp. Bracket |
| | | ALTERNATOR & VOLTAGE REGULATOR |
| 25-40 | 3/8-16 | Nut - Alternator & Pulley Assy. to Bracket & Plate |
| 10-25 | 5/16-18 | Bolt - Alternator & Pulley Assy. to Adj. Strap |
| 25-40 | 3/8-16 | Bolt - Alternator & Bracket Ext. Plate to Bracket & Head |
| 25-35 | 3/8-16 | Bolt - Alternator Mounting Bracket to Cylinder Head |
| | | STARTING MOTOR & CONTROL |
| 20-45 | 3/8-16 | Bolt - Starting Motor to Cylinder Block |
| | 1/4-20 | Nut - Starting Motor Brace to Starting Motor |
| | | DISTRIBUTOR |
| 15-25 | 3/8-16 | Bolt - Distributor - Hold Down Clamp |
| | | IGNITION SWITCH, WIRES, ETC. |
| 20-35 | 3/8-16 | Bolt - Coil Assembly to Cylinder Block |
| | | MUFFLER, EXHAUST PIPES & TAIL PIPES |
| 15-20 | 5/16-18 | Nut - Exhaust Pipe to Muffler U-Bolt |
| 25-35 | 3/8-16 | Bolt - Exhaust Pipe to Manifolds |
| 15-20 | 5/16-18 | Nut - Muffler to Tail Pipe "U" Bolt |
| 6-9 | 20-9 | Screw - Clamp to Tail Pipe Hanger |
| 10-15 | 5/16-18 | Screw - Tail Pipe Hanger to Frame |
| 10-15 | 5/16-18 | Screw - Muffler to Tail Pipe Hanger to Frame |

*Torque not a requirement, other means of control and/or specifications used, check for alignment, bottoming, height and/or leaks.

## TROUBLE DIAGNOSIS

### *ENGINE FAILS TO START*

CAUSE:

a. Corroded or loose battery terminal connections and/or weak battery.

b. Broken or loose ignition wires and/or faulty ignition switch.

c. Excessive moisture on plugs, caps or ignition system.

d. Damaged distributor rotor, cracked distributor cap and/or corroded distributor contact points.

e. Fouled spark plugs and/or improper spark plug gap.

f. Weak or faulty coil.

g. Carburetor flooded and/or fuel level in carburetor bowl not correct.

h. Dirt and water in gas line or carburetor.

i. Sticking choke.

j. Faulty fuel pump.

k. Faulty solenoid or starting motor.

l. Park or neutral switch inoperative.

### *ENGINE "LOPES" WHILE IDLING*

CAUSE:

a. Air leaks between intake manifold and heads.

b. Blown head gasket.

### *ENGINE "LOPES" WHILE IDLING (Cont'd)*

c. Worn timing gears chain or sprockets.

d. Worn camshaft lobes.

e. Overheated engine.

f. Plugged crankcase vent valve.

### *ENGINE MISSES WHILE IDLING*

CAUSE:

a. Spark plugs damp or gap incorrectly set.

b. Excessive moisture on ignition wires and caps.

c. Leaks in ignition wiring.

d. Ignition wires making poor contact.

e. Uneven compression.

f. Burned, pitted or incorrectly set contact points.

g. Faulty coil or condenser.

h. Worn distributor cam or cracked distributor cap.

i. Incorrect carburetor idle adjustment and/or dirty jets or plugged passages in carburetor.

j. Foreign matter, such as dirt or water, in gas line or carburetor.

k. Air leak at carburetor mounting gasket.

l. Choke inoperative.

m. Faulty spark advance mechanism.

n. Burned, warped, pitted, or sticking valves.

o. Incorrect valve lifter clearance.

p. Low compression.

### *ENGINE MISSES AT VARIOUS SPEEDS*

CAUSE:

a. Dirt and water in gas line or carburetor.

b. Fouled carburetor jets.

c. Incorrect ignition timing.

d. Points dirty, pitted or incorrectly spaced.

e. Excessive play in distributor shaft.

f. Insufficient spring tension on points.

g. Distributor cam lobe worn.

h. Weak coil or condenser.

i. Spark plugs dirty or damp and/or gaps set too wide.

j. Insufficient point dwell.

k. Detonation or pre-ignition.

l. Heat control valve not functioning properly.

m. Excessively worn fuel pump diaphragm.

n. Weak valve spring.

o. Worn camshaft lobes.

p. Engine overheating.

q. Sub-standard fuel.

### *ENGINE STALLS*

CAUSE:

a. Carburetor idle speed set too low and/or idle mixture too rich or too lean.

b. Carburetor needle valve and seat inoperative.

c. Incorrect carburetor float level and/or carburetor flooding.

d. Dirt or water in gasoline or carburetor.

e. Choke improperly adjusted or sticking.

f. Faulty ignition system.

g. Spark plugs damp or dirty and/or gaps incorrectly set.

h. Faulty coil or condenser.

i. Distributor points burned, pitted, dirty, or incorrectly set.

### ENGINE STALLS (Cont'd)

j. Distributor advance inoperative.

k. Exhaust system restricted.

l. Leaks in carburetor mounting gasket or intake manifold.

m. Incorrect valve lifter clearance.

n. Burned, warped, or sticking valves.

o. Low compression.

p. Engine overheating.

### ENGINE HAS NO POWER

CAUSE:

a. Weak coil or condenser.

b. Incorrect ignition timing.

c. Excessive play in distributor shaft or distributor cam worn.

d. Insufficient point dwell.

e. Spark plugs dirty or gaps incorrectly set.

f. Carburetor not functioning properly.

g. Improper carburetor float level.

h. Carburetor fuel mixture too rich or too lean.

i. Foreign matter, such as dirt or water, in gas line or carburetor.

j. Faulty fuel pump.

k. Valve springs weak and/or valves sticking when hot.

l. Burned, warped, or pitted valves.

m. Valve timing incorrect.

n. Incorrect valve lifter clearance.

o. Worn camshaft lobes.

p. Pistons incorrectly fitted in block.

q. Blown cylinder head gasket.

r. Low compression.

s. Flow control valve inoperative (Power Steering).

t. Clutch slipping.

u. Brakes dragging.

v. Engine overheating.

w. Transmission regulator valve sticking (Hydra-Matic).

x. Faulty spark plug wires.

y. Sub-standard fuel.

z. Fuel filter plugged.

### EXTERNAL ENGINE OIL LEAKAGE

CAUSE:

a. Improperly seated or broken fuel pump gasket.

b. Improperly seated or broken push rod cover gasket.

c. Improperly seated or broken oil filter gasket.

d. Broken or improperly seated oil pan gasket.

e. Gasket surface of oil pan bent or distorted.

f. Improperly seated or broken timing chain cover gasket.

g. Worn timing chain cover oil seal.

h. Worn or improperly seated rear main bearing oil seal.

i. Engine oil pan drain plug improperly seated.

j. Rear camshaft bearing drain hole plugged.

k. Loose rocker arm covers, gasket broken, or cover distorted or bent.

### EXCESSIVE OIL CONSUMPTION DUE TO OIL ENTERING COMBUSTION CHAMBER THROUGH HEAD AREA

CAUSE:

a. Intake valve seals damaged or missing.

b. Worn valve stems or guides.

c. Cylinder head porous between oil gallery and intake ports.

d. Plugged drain back holes in head.

e. Intake manifold gasket leak in conjunction with rocker cover gasket leak.

f. Cylinder head gasket leak at head oil gallery feed passage.

### EXCESSIVE OIL CONSUMPTION DUE TO OIL ENTERING COMBUSTION CHAMBER BY PASSING PISTON RINGS

CAUSE:

a. Oil level too high.

b. Excessive main or connecting rod bearing clearance.

c. Piston ring gaps not staggered.

d. Incorrect size rings installed.

e. Piston rings out of round, broken or scored.

f. Insufficient piston ring tension due to engine overheating.

g. Ring grooves or oil return slots clogged.

h. Rings sticking in ring grooves of piston.

i. Ring grooves worn excessively in piston.

j. Compression rings installed upside down.

k. Excessively worn or scored cylinder walls.

l. Oil too thin.

### NO OIL PRESSURE WHILE IDLING

CAUSE:

a. Faulty oil gauge.

b. Oil pump not functioning properly. (Regulator ball stuck in position by foreign material).

c. Excessive clearance at main and connecting rod bearings.

d. Loose camshaft bearings.

e. Leakage at internal oil passages.

### NO OIL PRESSURE WHILE ACCELERATING

CAUSE:

a. Oil pump not functioning properly.

b. Low oil level in oil pan.

c. Leakage at internal oil passages.

### BURNED, STICKING OR BROKEN VALVES

CAUSE:

a. Weak valve springs.

b. Improper valve lifter clearance.

c. Improper valve guide clearance and/or worn valve guides.

d. Out-of-round valve seats or incorrect valve seat width.

e. Deposits on valve seats and/or gum formation on stems or guides.

f. Warped valves or faulty valve forgings.

g. Exhaust back pressure.

h. Improper spark timing.

### NOISY VALVES

CAUSE:

a. Incorrect valve lifter clearance.

b. Excessively worn or faulty valve lifters.

c. Worn valve guides.

d. Excessive run-out of valve seat or valve face.

e. Worn camshaft lobes.

f. Pulled or loose rocker arm studs.

g. Bent push rods.

### NOISY PISTONS AND RINGS

CAUSE:

a. Excessive clearance between piston and bore.

b. Improper fit of piston pin.

c. Excessive accumulation of carbon in heads.

d. Connecting rods improperly aligned.

e. Excessive clearance between rings and grooves.

f. Rings broken.

### BROKEN PISTONS AND/OR RINGS

CAUSE:

a. Undersize pistons installed.

b. Wrong type and/or size rings installed.

c. Cylinder bores tapered or eccentric.

d. Connecting rods improperly aligned.

e. Excessively worn ring grooves.

f. Rings improperly assembled.

g. Insufficient ring gap clearance.

h. Engine overheating.

i. Fuel of too low octane rating.

### NOISY CONNECTING RODS

CAUSE:

a. Connecting rods improperly aligned.

b. Excessive bearing clearance.

c. Eccentric or out-of-round crankshaft journals.

d. Insufficient oil supply.

e. Low oil pressure.

f. Connecting rod bolts not tightened correctly.

### NOISY MAIN BEARINGS

CAUSE:

a. Low oil pressure and/or insufficient oil supply.

b. Excessive bearing clearance.

c. Excessive crankshaft end play.

d. Eccentric or out-of-round crankshaft journals.

e. Sprung crankshaft.

f. Excessive belt tension.

g. Loose harmonic balancer.

### NOISY VALVE LIFTERS

CAUSE:

a. Broken valve springs.

b. Worn or sticking rocker arms.

c. Worn or bent push rods.

***NOISY VALVE LIFTERS (Cont'd)***

d. Valve lifters incorrectly fitted to bore size.

e. Faulty valve lifter plunger or push rod seat.

f. Plungers excessively worn causing fast leak-down under pressure.

g. Excessively worn camshaft lobes.

h. Valve lifter oil feed holes plugged causing internal breakdown.

i. Faulty valve lifter check ball. (Nicked, flat spot, or out of round).

j. Rocker arm retaining nut installed upside down.

k. End of push rod excessively worn or flaked.

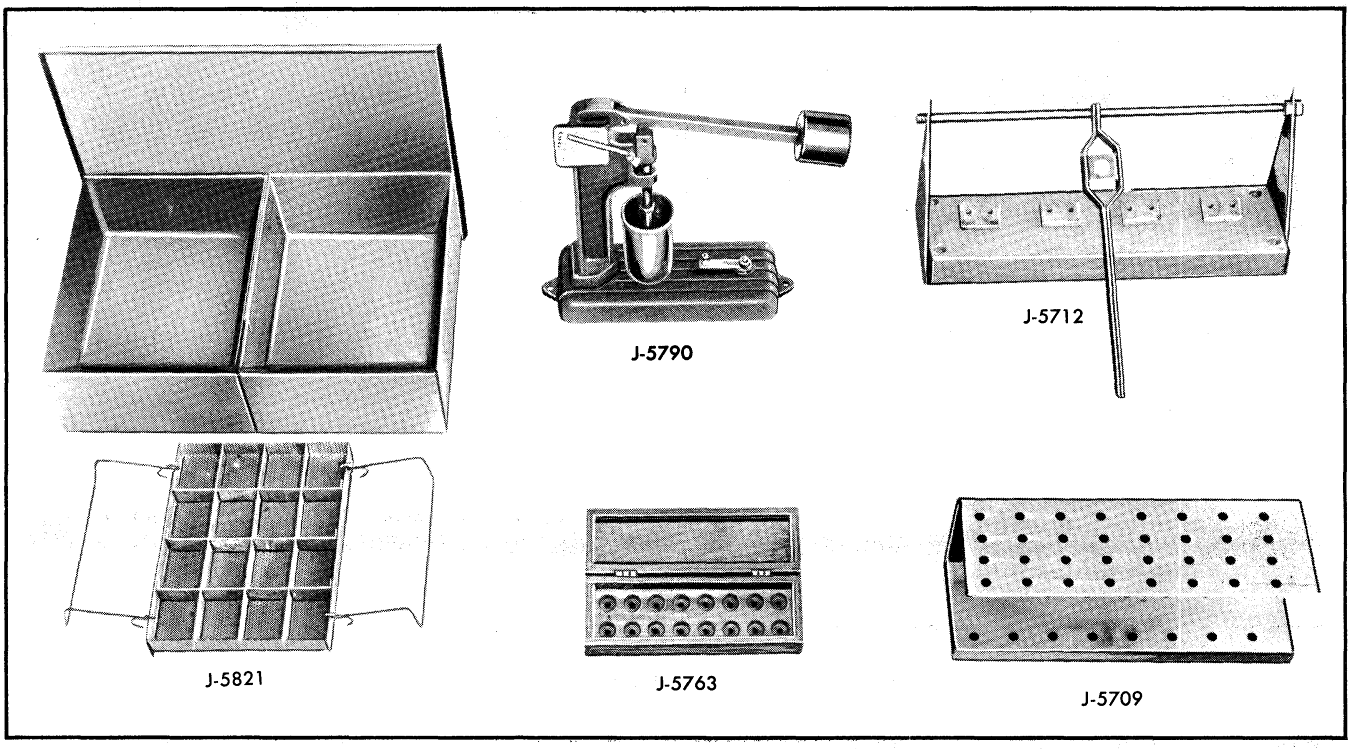



Fig. 6-155 Special Engine Tools

J-5709 Valve and Valve Train Holding Stand

J-5712 Cylinder Head Holder and Valve Spring Compressor

J-5763 Hydraulic Valve Lifter Storage Box

J-5790 Hydraulic Valve Lifter Tester

J-5821 Hydraulic Valve Lifter Solvent Tank and Tray

J-21147 Timing Chain Cover Seal Installer

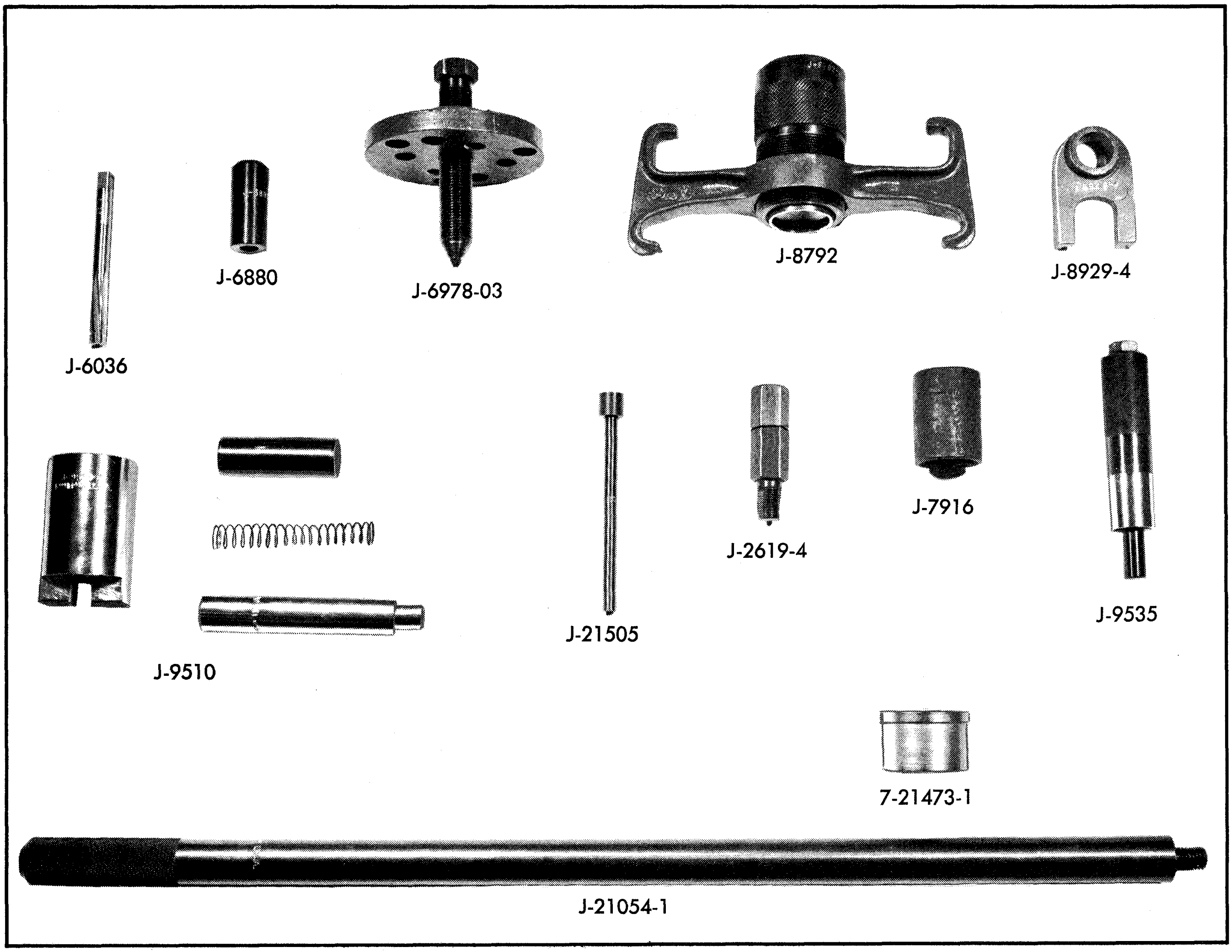



Fig. 6-156 Special Engine Tools (6 Cylinder Engine)

| | |
|---|---|
| J-6036 | Rocker Arm Stud Reamer (.013 O.S.) |
| J-6880 | Rocker Arm Stud Installer |
| J-6978-03 | Harmonic Balancer Puller |
| J-8792 | Harmonic Balancer Installer |
| J-8929-4 | Valve Spring Compressor Adapter |
| J-9510 | Piston Pin Remover and Replacer |
| J-21505 | Fan Hub Locating Gauge |
| J-2619-4 | Slide Hammer Adapter |
| J-7916 | Oil Signal Sending Switch Socket |
| J-9535 | Distributor Shaft Bearing Installer Burnisher |
| J-21473-1 | Adapter - Camshaft Bushing Remover and Replacer |
| J-21054-1 | Handle - Camshaft Bushing Remover and Replacer |

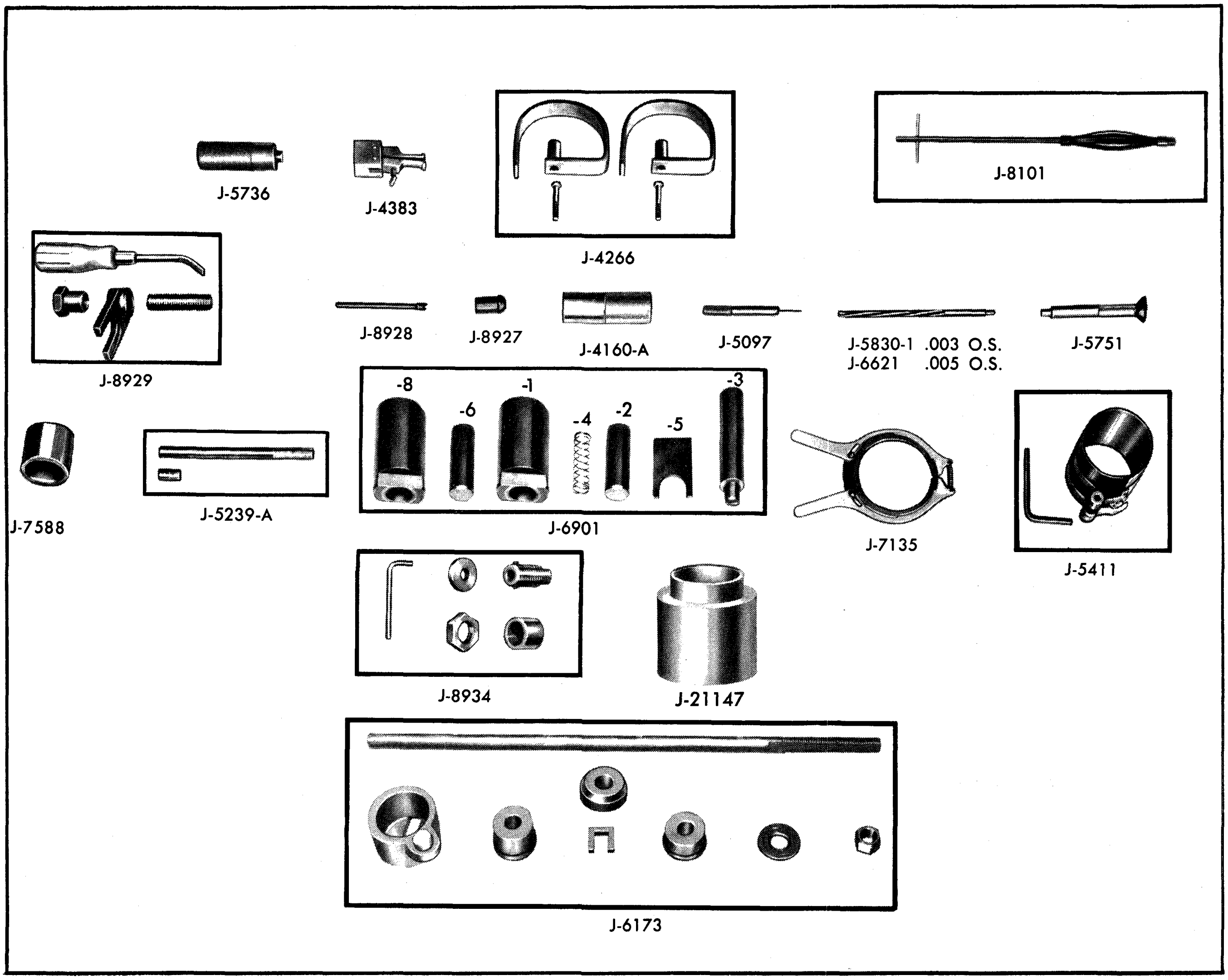



Fig. 6-157 Engine Special Tools

| | | | |
|---|---|---|---|
| J-4160-A | Hydraulic Valve Lifter Plunger Remover | J-8927 | Rocker Arm Stud Installer |
| J-4266 | Cylinder Head Lifting Hooks | J-8928 | Valve Train Gauge |
| J-5097 | Hydraulic Valve Lifter Plunger Unloading Tool | J-8929 | Valve Spring Compressor Set |
| J-5239-A | Connecting Rod Bolt Guide Set | J-8934 | Rocker Arm Stud Remover |
| J-5411 | Piston Ring Compressor | J-6621 | Valve Guide Reamer .005 oversize |
| J-5751 | Intake and Exhaust Valve Stem Installer and Tester | J-6901 | Piston Pin Remover and Replacer Set |
| J-5830-1 | Valve Guide Reamer .003 oversize | J-7135 | Piston Ring Remover and Replacer |
| J-6173 | Camshaft Bearing Remover and Replacer | J-7588 | Rear Main Bearing Oil Seal Installer |

# ENGINE COOLING AND LUBRICATION

CONTENTS OF THIS SECTION



## COOLING SYSTEM DESCRIPTION

The cooling system consists of the radiator core, cooling fan, pellet type thermostat, water pump and suitable passages for water circulation through the engine.

### RADIATOR

Seven different radiators are used on Tempest cars. They may be identified by the radiator core stamped on upper inside right corner of top tank.

| CODE | USAGE |
|---|---|
| 151 | 215 6 cyl. Engine |
| 152 | 215 6 cyl. A/C |
| 155 | 326 V-8 SM |
| 153 | 326 V-8 Auto. |
| 157 | 326 V-8 A/C |
| 156 | 326 V-8 H.O. |
| 158 | 326 V-8 H.O. A/C |

The radiator is of the down-flow tube and center type and is constructed of copper. A drain cock is located at the inside lower left corner of the radiator.

A pressure-vent type cap is used on the radiator to allow a build-up of 14-17 psi of pressure in the cooling system. This pressure raises the boiling point of coolant 46°.

*CAUTION: As long as there is pressure in the cooling system, the temperature can be considerably higher than the normal boiling temperature of the solution in the radiator without causing the solution to boil. Removal of the radiator cap while the engine is hot and the pressure is high will*

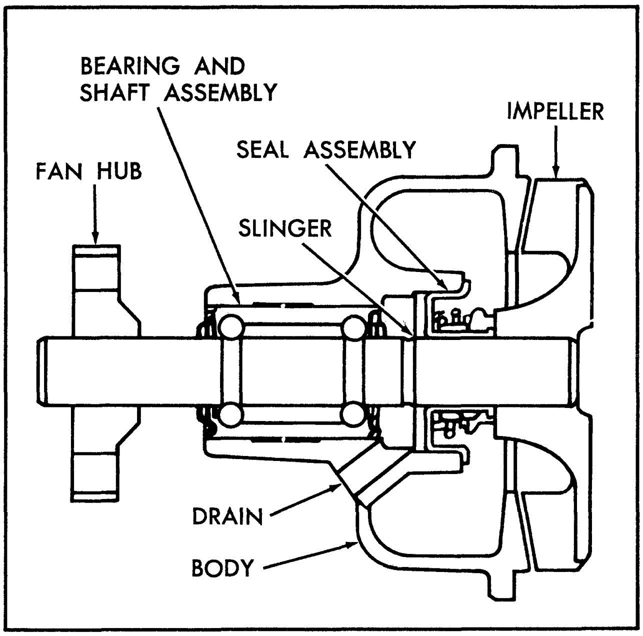



Fig. 6A-1 6 Cyl. Water Pump Cross-Section

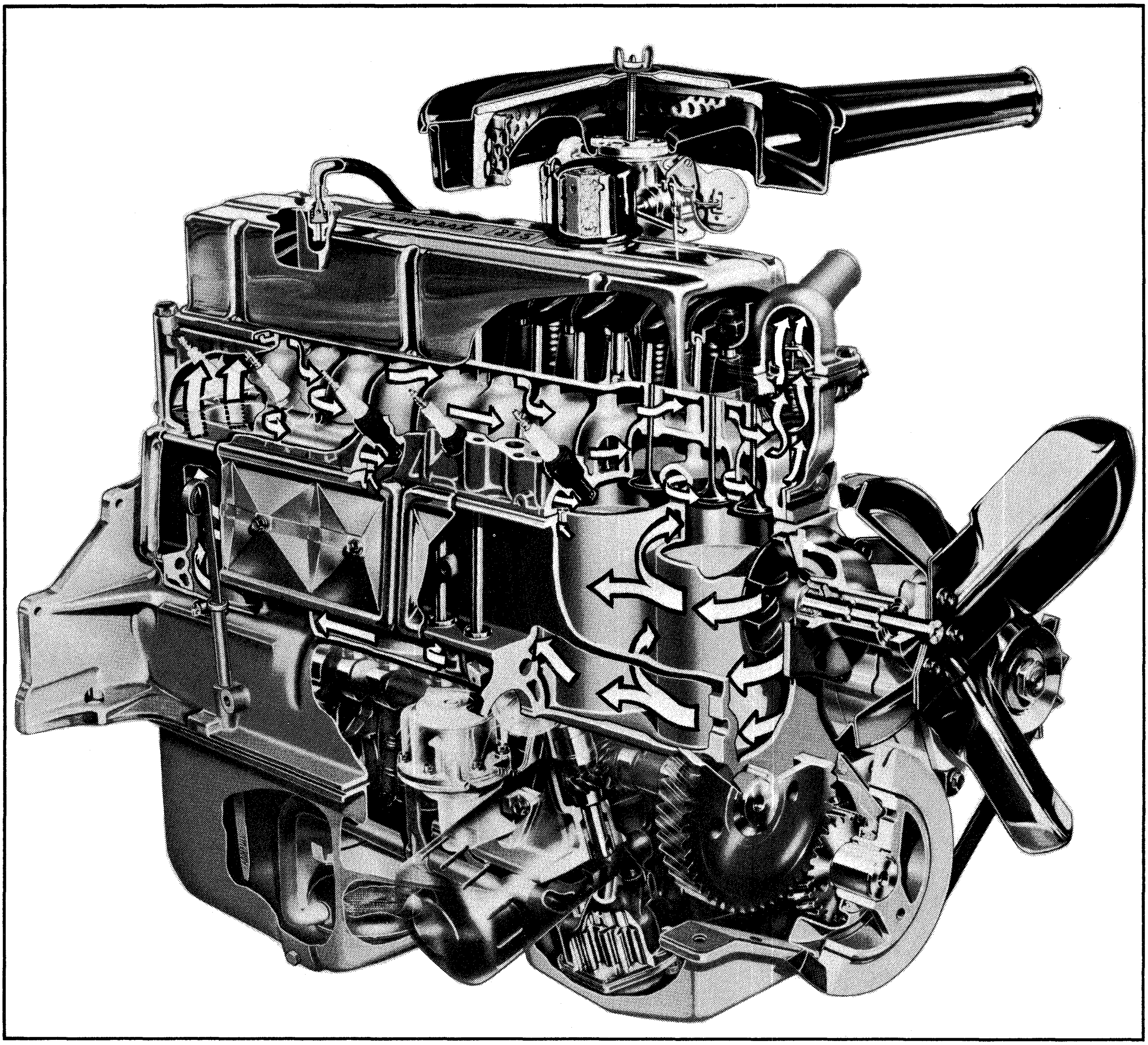


Fig. 6A-2 6 Cyl. Cooling System Circulation

*cause the solution to boil instantaneously and possibly with explosive force, spewing the solution over the engine, fenders, and the person removing the cap. If the solution contains inflammable anti-freeze (not recommended), such as alcohol, there is also the possibility of causing a serious fire. When removing filler cap, rotate cap toward left very slowly; if hissing of vapor is encountered, tighten cap immediately and wait for system to cool sufficiently to allow removal of cap. After pressure in the system has been relieved, turn cap more forcibly to left and remove. Turn cap all the way to the right when installing. It should not be necessary to check coolant level unless temperature gauge shows over-heating, and then not until engine is stopped and allowed to cool to normal.*

## FAN

The fan is used to increase the air flow through the radiator at low speeds.

The standard fan has four blades. A seven bladed fan is used on cars with air conditioners and has curled tips to provide minimum noise.

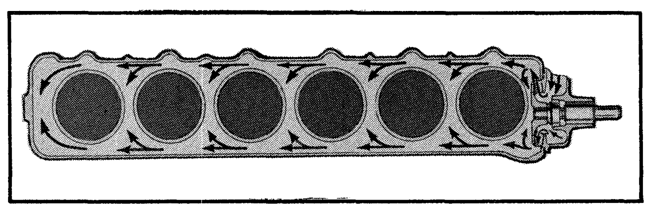


Fig. 6A-3 6 Cyl. Cylinder Block Coolant Circulation

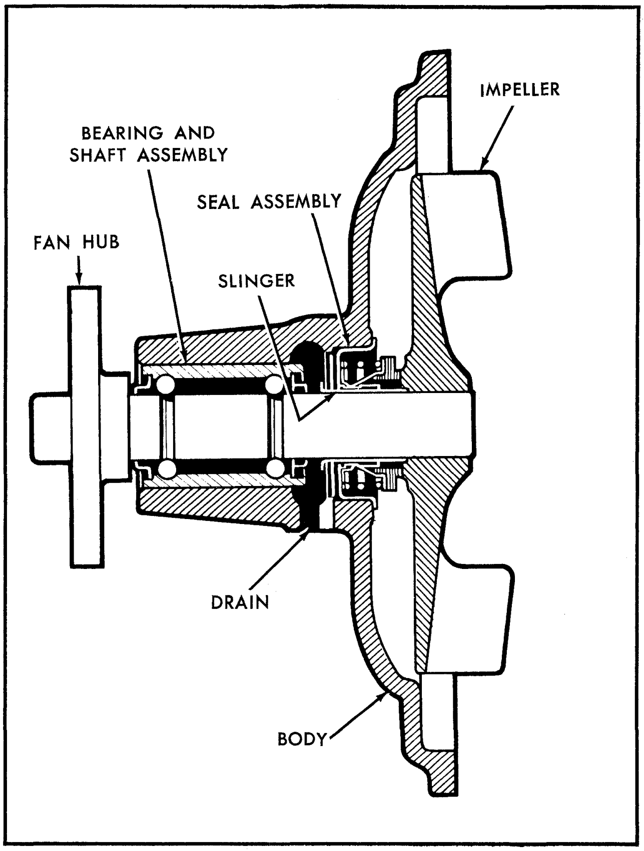



Fig. 6A-4 V-8 Water Pump

### *THERMOSTAT*

A pellet type thermostat is used in the engine water outlet passage. The thermostat controls the flow of coolant to provide rapid engine warm up and regulate coolant temperature. A thermostat is installed as standard equipment.

### *WATER PUMP—6 CYL. (Fig. 6A-1)*

The centrifugal type water pump contains an impeller which turns on a steel shaft which rotates in a ball bearing. A bellows type seal is seated in the water pump body between the bearing and impeller.

The inlet side of the pump is connected to the lower radiator tank by a hose. Above the pump inlet from the radiator is the inlet from the heater core. Located in the coolant outlet at the front of the cylinder head is the outlet to the heater core from beneath the thermostat.

### *COOLING SYSTEM CIRCULATION— 6 CYL. (Fig. 6A-2)*

The water pump discharges coolant into the water jacket chamber between the front face of the block

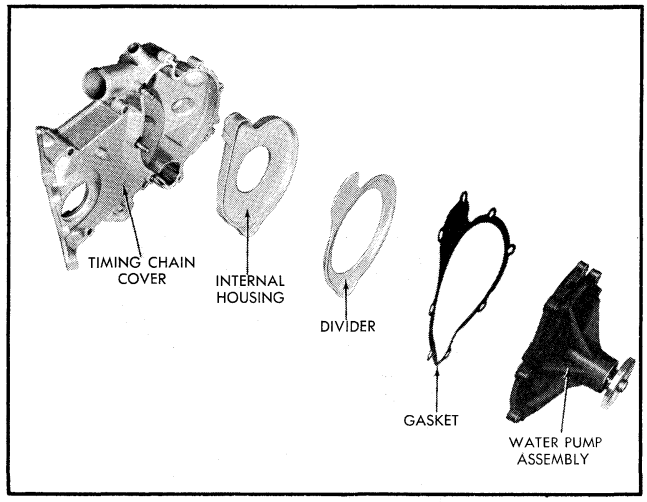



Fig. 6A-5 V-8 Water Pump Assembly and Timing Chain Cover Exploded View

and the number one barrel (Fig. 6A-3). Coolant then flows through the block toward the rear passing through two large cast openings into the cylinder head to cool the valve seats and forward to the front of the head. Coolant then flows through the coolant outlet and the pellet type thermostat to the radiator. Some coolant is directed through a small hole in the cylinder head gasket to an area around each spark plug.

During engine warm-up, when the thermostat is closed, water is redirected to the engine.

### *WATER PUMP V-8 (Fig. 6A-4)*

The centrifugal type water pump, divider, internal housing and aluminum timing chain cover are all part of the coolant circulation system (Fig. 6A-5).

The water pump impeller turns on a steel shaft mounted on a double row permanently lubricated, sealed ball bearing (Fig. 6A-4). A bellow type seal is seated in the water pump body between the bearing and impeller. The seal surface is a phenolic washer which is held by the spring loaded bellows against a machined surface on the impeller.

The inlet side of the pump is connected to the lower radiator tank by means of a hose. A water leg, in the intake manifold connects to the timing chain cover to provide recirculation of water when the thermostat is closed. The timing chain cover also has a heater water return connection.

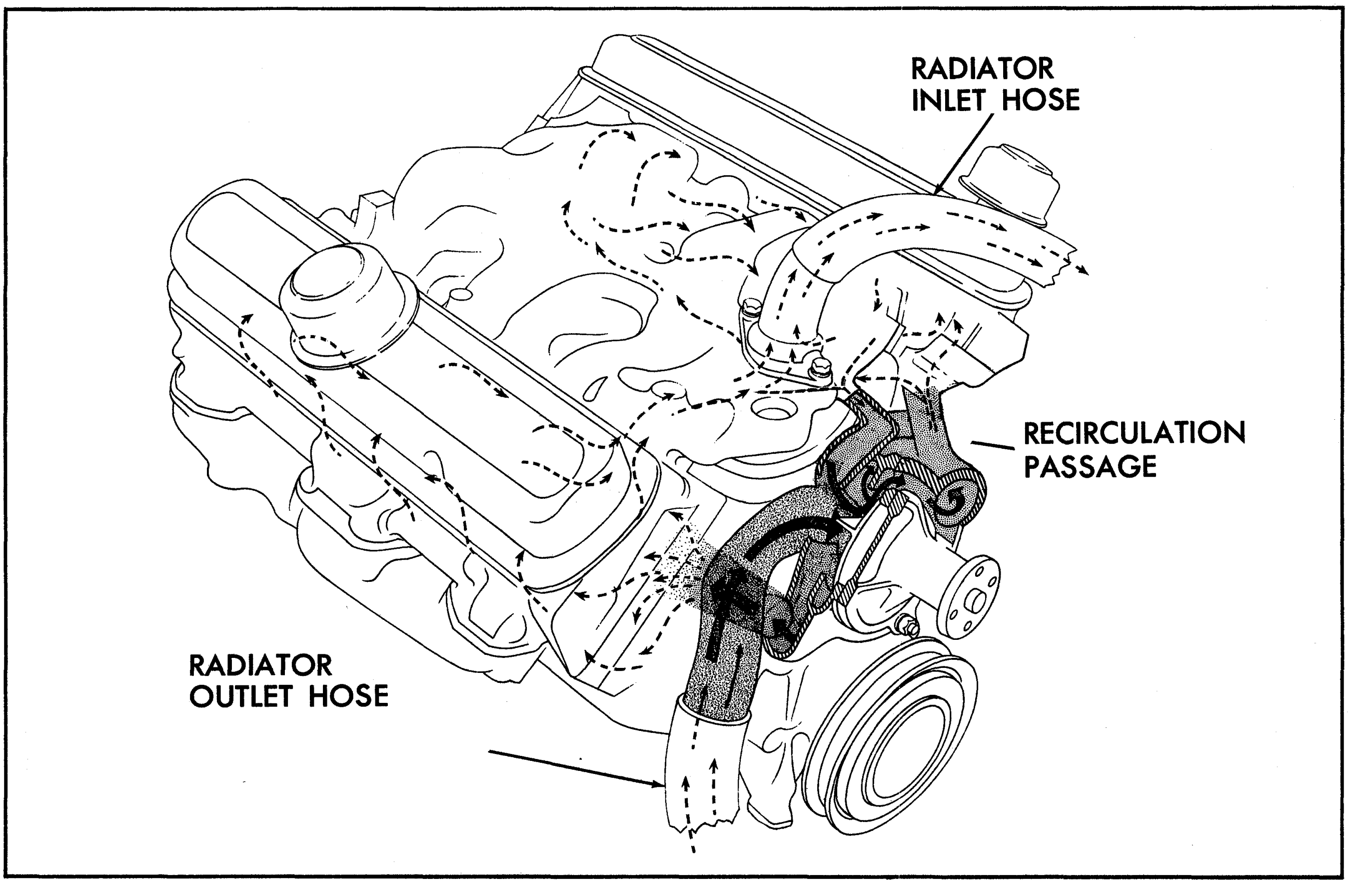



Fig. 6A-6 V-8 Cooling System Circulation

### *COOLING SYSTEM CIRCULATION—V-8 ENGINE*

Water circulation (Fig. 6A-6) is provided by a single impeller, specially designed water pump which provides flow of water into the cylinder block.

Water circulation during warm-up (thermostat closed) is from the pump to the cylinder block, up into the cylinder head, into the front of the intake manifold, and back to the inlet of the pump, via the timing chain cover, which acts as a pump body. The inlet side of the pump has a heater water return connection.

After normal operating temperatures are reached (thermostat open), part of the water will recirculate as outlined above. A major portion of the water, however, will pass into the radiator via the outlet passage and hose above the thermostat. It will then circulate back to the pump inlet. The water pump and the water transfer holes between the block and cylinder head have been designed to provide the proper flow of coolant to provide temperature balance within the engine bank and its cylinder head.

## LUBRICATION SYSTEM DESCRIPTION

### *OIL FILTER—6 CYL. AND V-8*

A full flow oil filter is standard equipment on the engine. The filter is mounted on a machined boss on the right front side (6 cyl.) and right rear side (V-8) of the engine block (Figs. 6A-7, 6A-8).

All oil from the pump passes through the filter before going to the engine oil galleries. In the filter, the oil passes through a filtering element where all dirt and foreign particles are removed.

A by-pass valve is located in the filter base casting to insure ample lubrication in case the filter element becomes restricted. Thus, if required, oil will flow directly from the inlet through the spring loaded by-pass valve to the outlet without any possibility of washing accumulated dirt off the filter element.

### *OIL PUMP—6 CYL. AND V-8 ENGINE—(Figs. 6A-9, 6A-10)*

Oil is circulated under pressure by a spur gear type pump. The pump is mounted on the right front

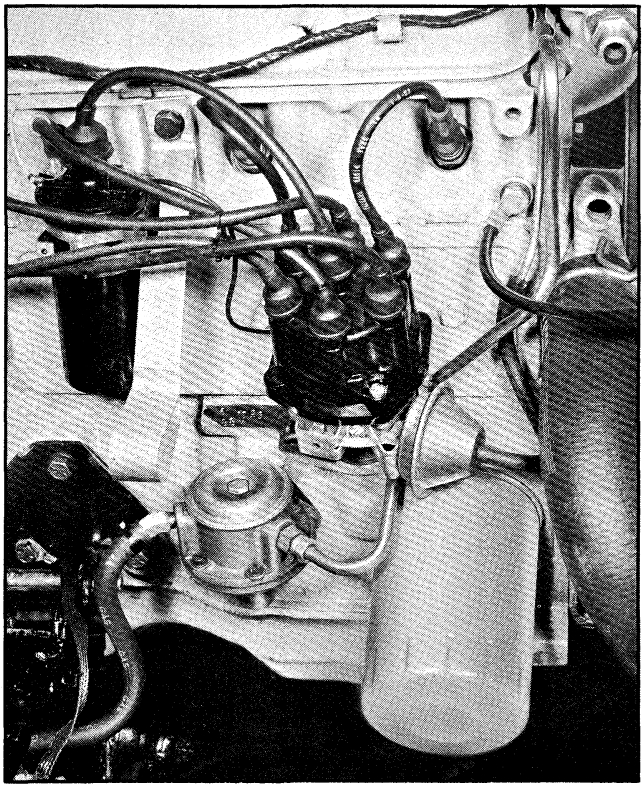


Fig. 6A-7 6 Cyl. Oil Filter Location

(6 cyl.) right rear (V-8) lower face of the cylinder block and is driven by the distributor drive gear. Maximum oil pressure is regulated by a spring loaded, ball type, pressure regulator valve. No adjustment of the pressure regulator valve is provided.

Oil is taken into the pump through a stationary type oil intake. All oil entering the floating intake passes through a screen. As a safety precaution a large hole is provided in the middle of the screen. During normal operation no oil can pass through this hole since the grommet around the hole is seated against the baffle. If the screen should become plugged, however, pump suction will cause the screen to move away from the baffle, and oil will flow through the large center hole.

### *OIL CIRCULATION—6 CYL. (Fig. 6A-11)*

Oil from the pump is directed through the full flow oil filter and then to the main gallery. The main gallery intersects the lifter bores and serves as both the main and lifter gallery where oil holes direct oil through passages to camshaft bearings and main bearings. Drilled passages in the crankshaft direct oil from the main bearings to connecting rod bearings. Oil from each lifter is directed up through

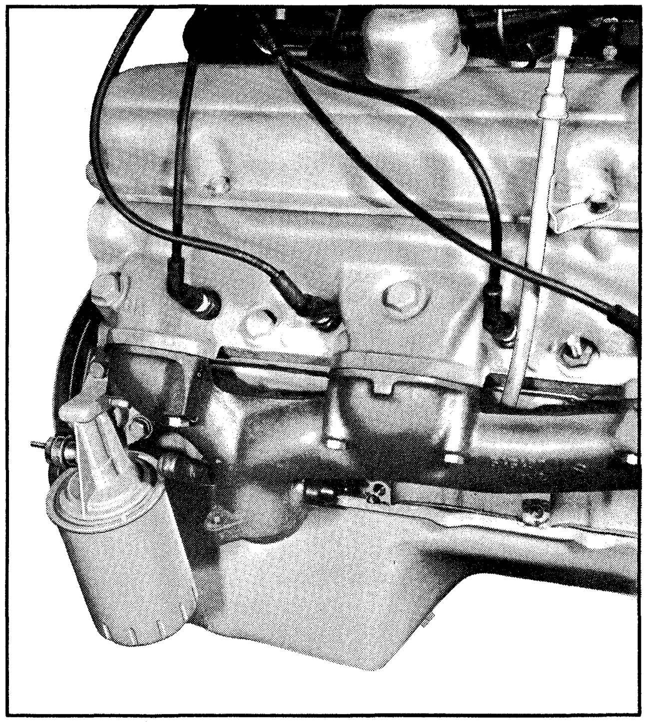


Fig. 6A-8 V-8 Oil Filter Location

hollow push rods to rocker arms. Oil then passes through a hole in the push rod contact area of the rocker arm and fills it. This supply lubricates the rocker arm ball. Over flow lubricates the top of the valve stem and other valve train surfaces (Fig. 6A-12).

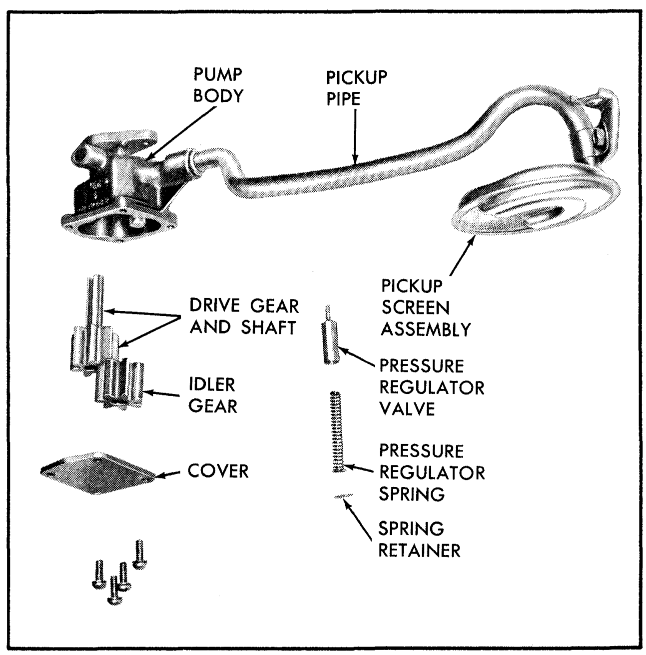



Fig. 6A-9 6 Cyl. Oil Pump Assembly

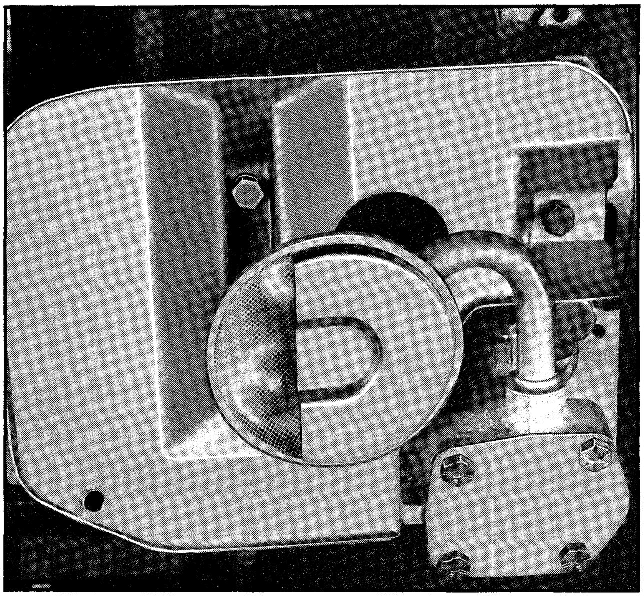


Fig. 6A-10 V-8 Oil Pump Assembly

Timing gears are lubricated by oil which is supplied through a passage from the front of the camshaft to a calibrated nozzle above the crankshaft gear (Fig. 6A-13).

Cylinder walls are lubricated with oil splash from connecting rods and crankshaft as they rotate.

### *OIL CIRCULATION—V-8 (Fig. 6A-14)*

The positive pressure system delivers oil under pressure to the crankshaft, connecting rod, and camshaft bearings and to the valve train parts. Spray from main and connecting rod bearings lubricates the cylinder walls, piston pins and bushings. Timing chain and sprockets receive metered jet lubrication as do the fuel pump eccentric and rocker arm. A hole in the block from the push rod gallery through the distributor boss lubricates the distributor shaft and bushings.

Oil flow through the engine is as follows: Oil is first supplied by the pump and filter to two parallel oil galleries drilled in the block on each side of the camshaft. Oil travels from rear to front in the left gallery and from front to rear in the right gallery. The rear crankshaft and camshaft bearings receive oil from a hole drilled through the passage connecting the filter to the left gallery. All other crankshaft bearings receive oil from holes drilled to the left hand gallery. The remaining four camshaft bearings are supplied by a hole drilled vertically from each crankshaft bearing journal to camshaft bearing journal.

Hydraulic valve lifters are fed by holes drilled from each lifter boss to the oil gallery. Oil is fed under pressure from a hole in the push rod seat of the valve lifter up through the hollow push rod to provide pressure lubrication of both ends of the push rod.

Oil is also positively fed to the cylinder head to lubricate all valve train surfaces. An oil gallery in the head is fed from the front center camshaft journal. Oil from cylinder head gallery flows up holes in each rocker arm ball stud and out through a 1/16" hole drilled into the side of the stud to index with the ball. This oil lubricates the ball seat and also flows out through grooves in the top of the ball to fill the rocker arm with oil. Overflow from the rocker arm passes over the end onto the valve stem to lubricate the contact area between the rocker arm and the end of the valve stem.

Lubrication of the camshaft thrust plate, timing chain and sprockets, and fuel pump eccentric and rocker arm is provided for by a passage in the front of the camshaft. A lateral hole in the front bearing journal indexes with the camshaft bearing oil supply hole in the block once each revolution.

An oil jet then squirts out of the horizontal hole in the end of the camshaft toward the front of the engine. Part of this oil is projected straight forward, against the camshaft thrust plate. Another part of the oil is projected downward through the grooves in the block and thrust plate to the crankshaft timing chain sprocket (Fig. 6A-14). Oil passing down the groove also is forced out the hole in the thrust plate. The jet of oil from this hole is timed to pass through one of the openings in the camshaft sprocket and strike the fuel pump eccentric and rocker arm.

## POSITIVE CRANKCASE VENTILATION SYSTEM

The function of the positive crankcase ventilation system is to reclaim unburned fuel, prevent dilution and contamination of lubricating oils, and reduce the amount of harmful and irritating gases discharged into the atmosphere. The positive crankcase ventilation system utilizes the vacuum in the intake manifold to remove blow by gases from the crankcase and return them to the combustion chambers to be burned. The crankcase vent pipe is replaced by a valve (Fig. 6A-15) and rubber hose, which carry the gases from the crankcase to the intake manifold.

The valve automatically meters the flow of gases so that the normal operation of the engine is not

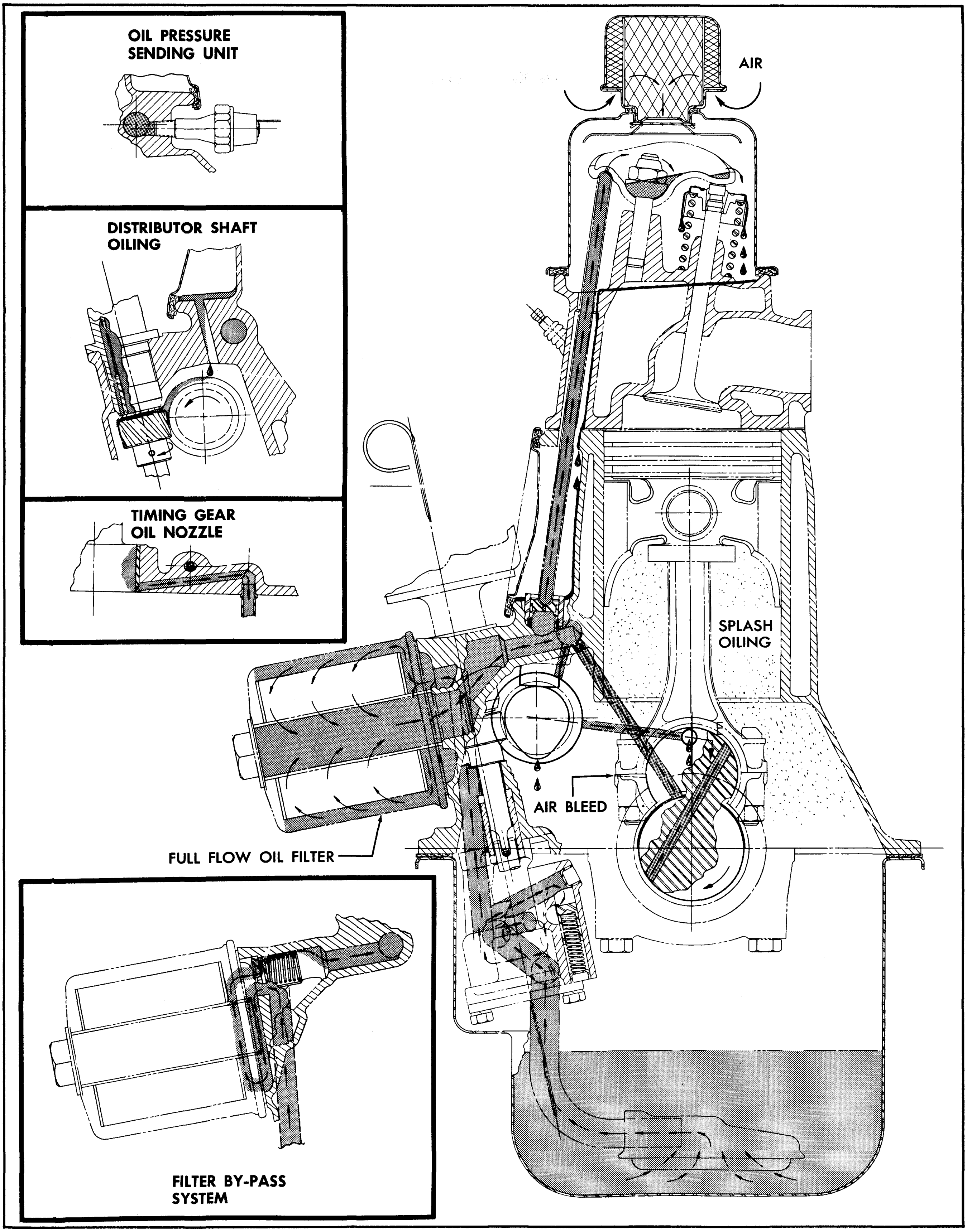



Fig. 6A-11 6 Cyl. Oil Circulation

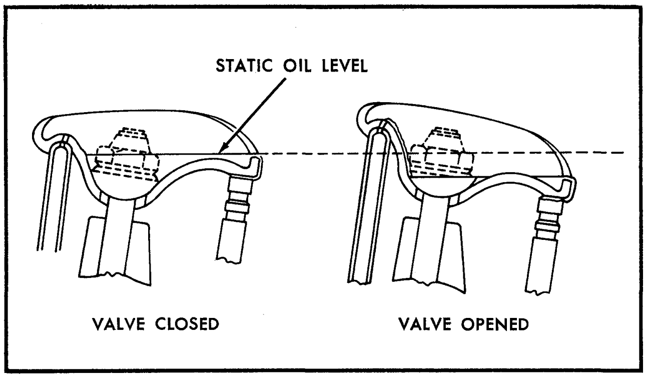



Fig. 6A-12 6 Cyl. Upper Valve Train Lubrication

disturbed. Valve is designed to vary its flow in proportion to manifold vacuum to handle increasing amounts of blowby as manifold vacuum decreases, (load and blowby increases). Should the engine backfire, the valve is automatically held closed by the reverse air flow to prevent fuel vapor from entering crankcase.

## SERVICE OPERATIONS

### *CHECKING AND FILLING COOLING SYSTEM*

The Tempest cooling system requires little care except for maintaining an adequate coolant level. If

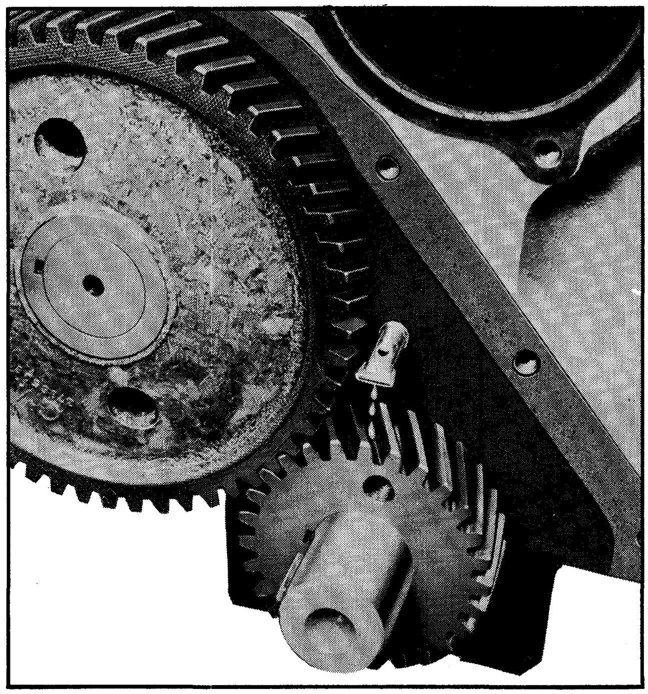


Fig. 6A-13 6 Cyl. Timing Gear Lubrication (Same as 6-5)

GM ethylene glycol type inhibited engine coolant is used, it is not necessary to drain the coolant for

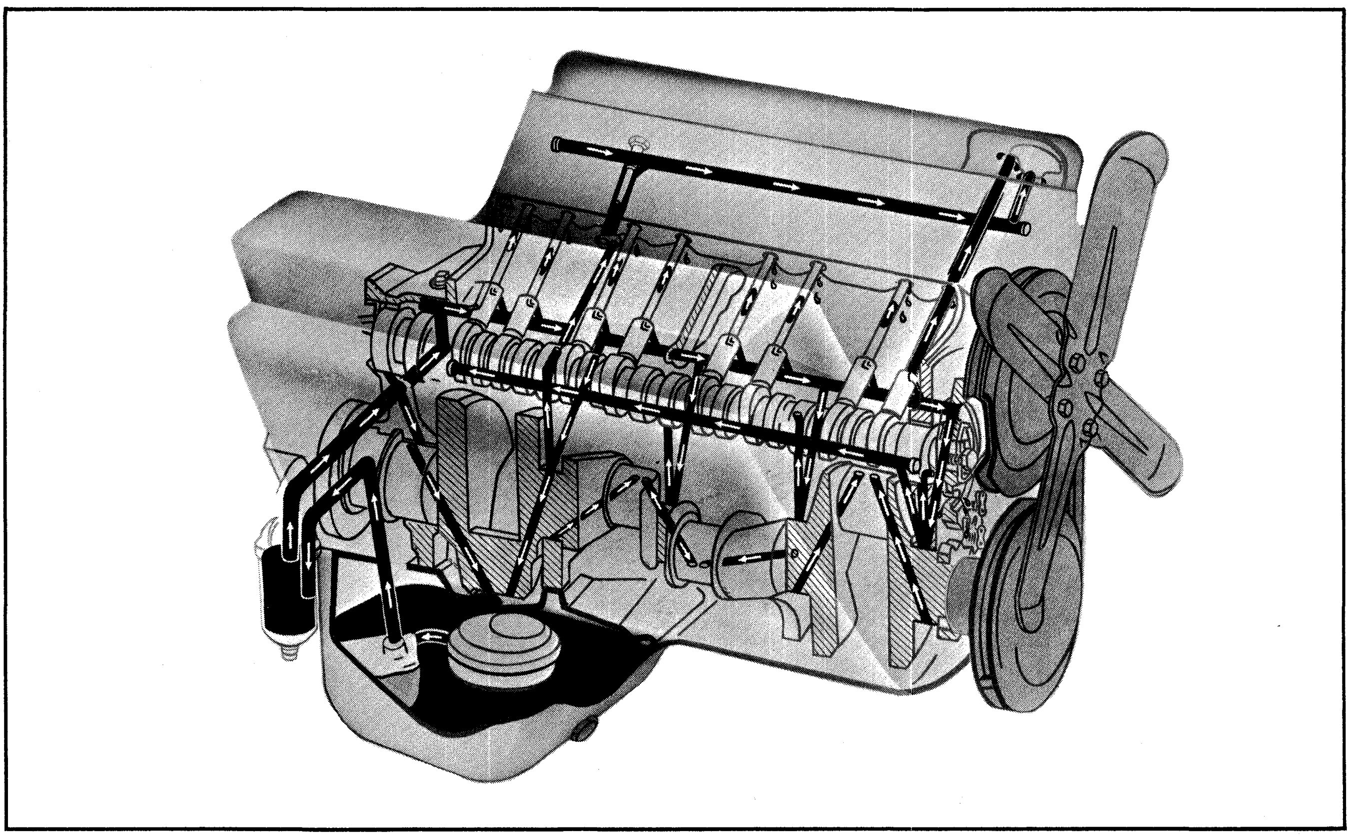


Fig. 6A-14 V-8 Oil Circulation

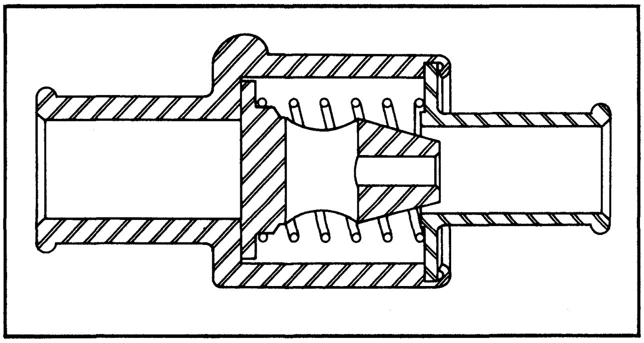


Fig. 6A-15 Positive Crankcase Ventilation Valve

summer driving because this coolant has been especially formulated to last 24 months in the cooling system. After service for 24 months, drain the system, flush it with water, and refill with an inhibited year-round coolant meeting the GM 1899M specification. If other than Pontiac approved inhibited glycol-type anti-freeze solution is used, the cooling system should be drained, flushed and refilled for the summer months. When water is used, a good corrosion inhibitor must be added to the system. Failure to use an inhibited coolant may result in severe corrosion damage to the cooling system components.

### FLUSHING COOLING SYSTEM

1. Drain radiator and block by opening drain plug on radiator lower tank and removing plug on left side of 6 cylinder engine block and on both sides of V-8 engine block.

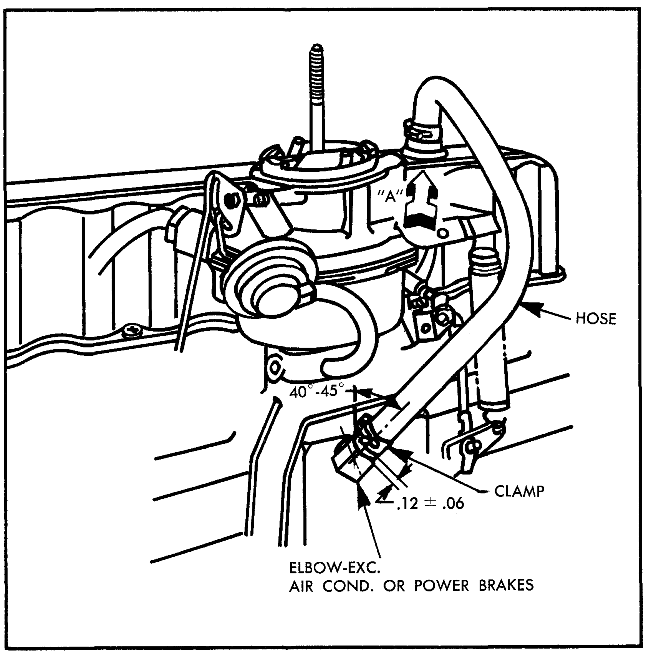



Fig. 6A-16 Positive Crankcase Ventilation
6 Cyl. 1 Bbl. Carb.

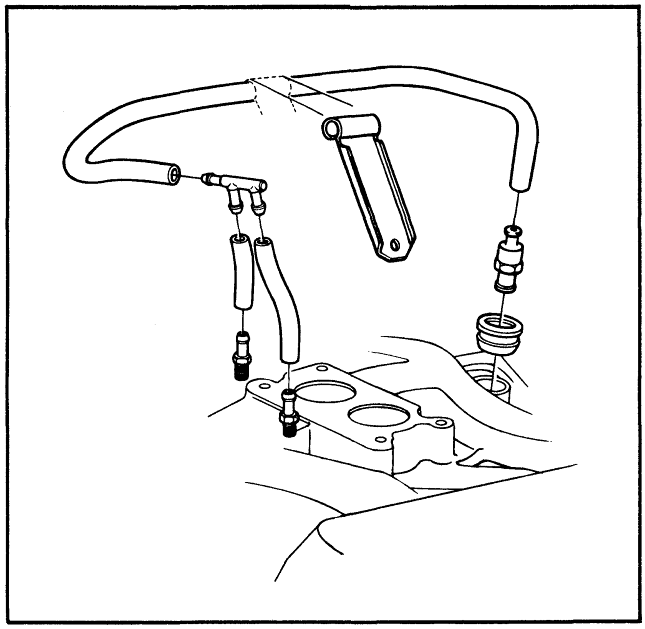


Fig. 6A-17 Positive Crankcase Ventilation
V-8 2 Bbl. Carb.

2. After system is empty, with drains open, run water into radiator. Engine should be running and occasionally accelerated to aid in circulating water and dislodge rust and scale.

*CAUTION: Do not introduce cold water into a hot*

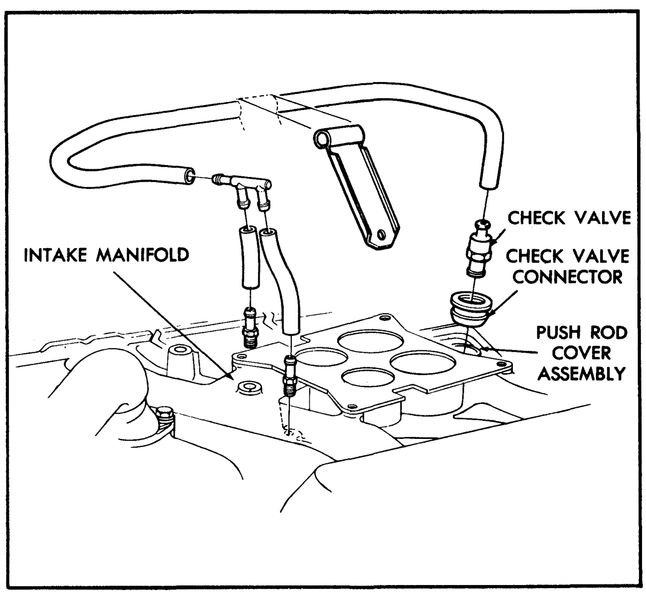



Fig. 6A-18 Positive Crankcase Ventilation
V-8 4 Bbl. Carb.

*engine or block may be cracked. Allow engine to cool, then add water with engine running.*

3. Where there is difficulty in getting water to run clear or there is an excessive amount of rust and scale, the cooling system should be cleaned with a cleanser (reputable source) supplied for that purpose. If force flushing equipment is used it should be used on the radiator only (engine to radiator inlet and outlet hoses removed) as any reverse flushing of the block with the water pump in place may cause the water pump seal to leak, if flushing pressure is excessive.

### PREPARING COOLING SYSTEM FOR COOLANT

The cooling system should be properly prepared for the addition of coolant every two years.

To properly prepare cooling system:

1. Bring engine up to operating temperature.

2. Flush out cooling system as instructed previously.

3. Tighten all hose connections on radiator, heater and defroster. Replace any deteriorated hose. Check to see that radiator hold down bolts are tightened properly.

4. Fill system with water and operate engine, checking for water leaks at radiator core, hose connections, water pump seal and gaskets, heater and defroster connections, and head to block joint.

5. Drain sufficient water to allow addition of proper quantity of coolant.

**DO NOT OVER FILL. COOLANT SHOULD BE ½—1" BELOW FILLER CAP OPENING**

*CAUTION: A pressure radiator cap is used to provide the best cooling. When removing, rotate the cap to the left very slowly. If a hissing noise is heard, stop and allow pressure to decrease before removing cap completely.*

To assure most effective heater performance, the Tempest has been equipped with a 180°F. thermostat. Therefore, the use of Pontiac approved inhibited ethylene glycol type engine coolant gives best heater performance.

Alcohol base coolant should not be used in Tempest automobiles.

### INHIBITORS

When only water is in the system, a cooling system corrosion inhibitor must be used.

### TESTING COOLANT

In using a hydrometer to determine the freezing point of radiator solution, make sure the correct hydrometer markings are read. Unless hydrometer is provided with means for temperature correction, test should be made at the temperature at which hydrometer is calibrated, for if the solution is warmer or colder large errors may result (in some cases as much as 30° F.) Most good hydrometers are equipped with a thermometer and temperature correction scale which allows an accurate test of freezing point over a range of temperatures.

### THERMOSTAT—REMOVE AND REPLACE

1. Drain radiator level to below thermostat and disconnect upper hose and remove water outlet assembly from cylinder head (6 cyl.), intake manifold (V-8).

2. Remove thermostat. Unless obviously defective, test the thermostat as follows, before replacing with new one:

   a. Immerse the unit and a thermometer in a container of water over a heater. While heating the water do not rest either the thermometer or thermostat on bottom of container as this will cause them to be at higher temperature than the water.

   b. Agitate the water to insure uniform temperature of water, thermostat and thermometer.

   A new thermostat (180°) valve should start to open (.002") at a temperature of 177°F. to 182°F., and should be fully (.380") or more at a temperature not in excess of 202°F. A used thermostat can be about 7°F. above or below this setting (170°-190°F.) without adverse effect and should not be replaced. If thermostat does not operate at specified temperatures, it should be replaced as it cannot be adjusted.

3. Install thermostat with pellet or cartridge projecting down into water passage in intake manifold.

4. Using new gasket, install water outlet fitting. Tighten bolts to 18-23 lb. ft. (6 cyl.), 20-35 lb. ft. (V-8).

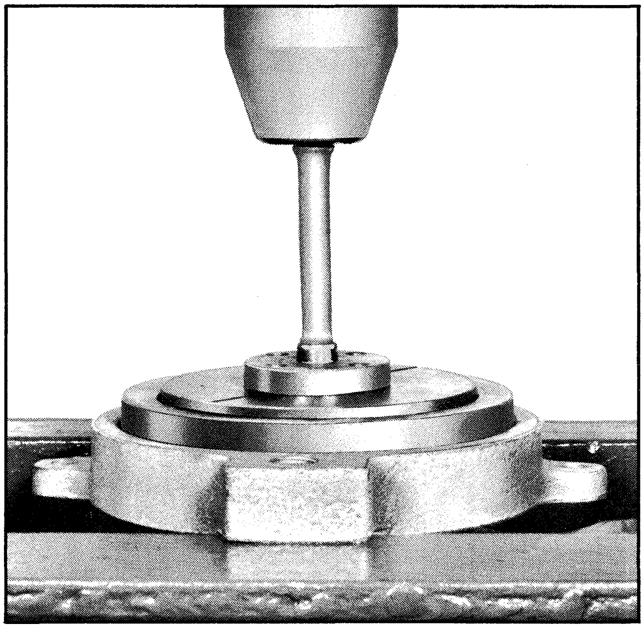


Fig. 6A-19 Pressing Pump Shaft From Hub (6 Cyl.)

5. Connect upper radiator hose.

6. Refill radiator to 1/2"-1" below filler cap opening.

### WATER PUMP—6 CYL.— REMOVE AND REPLACE

1. Drain radiator and remove water inlet hose from pump. Remove fan belt.

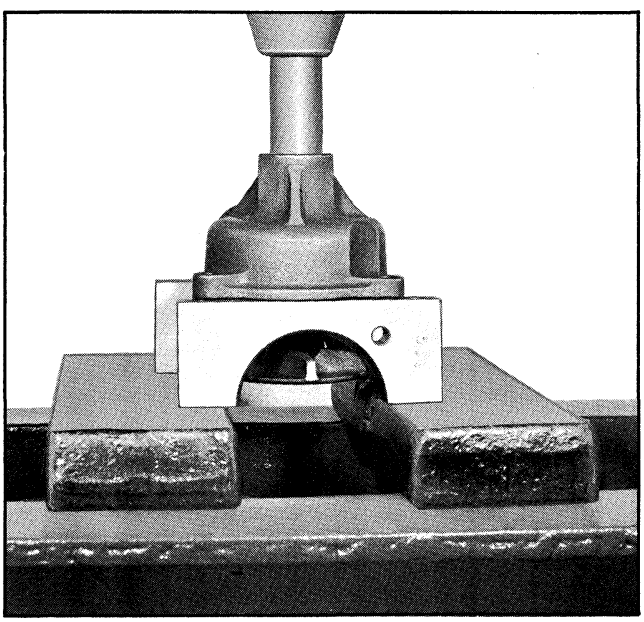


Fig. 6A-20 Pressing Shaft, Bearing and Impeller Assembly From Pump Housing

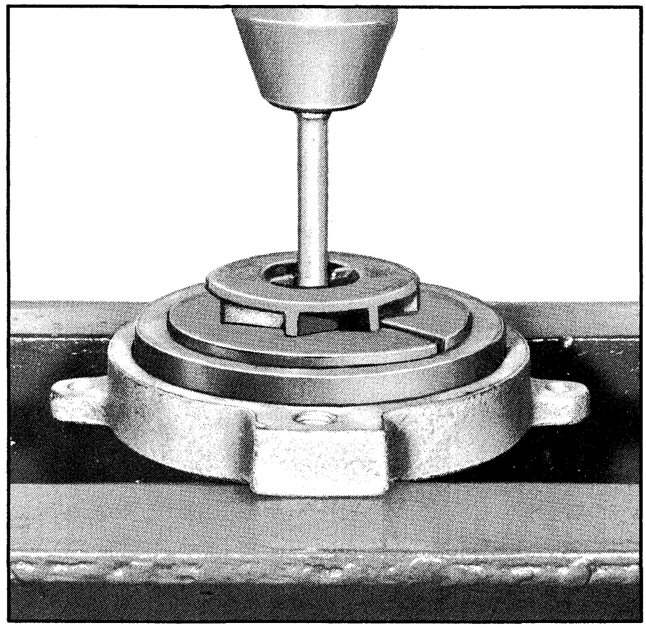


Fig. 6A-21 Pressing Shaft and Bearing Out of Impeller

2. Remove heater hose from pump housing.

3. Remove water pump to cylinder block attaching bolts and remove pump from engine.

*CAUTION: Pull pump straight out of cylinder block to avoid damage to impeller and shaft.*

4. Remove fan and pulley by removing four retaining bolts.

5. Support fan hub in an arbor press with press plates J-9156 and J-6407. Press pump shaft out of hub. A 1/2" x 2" bar will allow the shaft to be pushed through the hub. See Figure 6A-19.

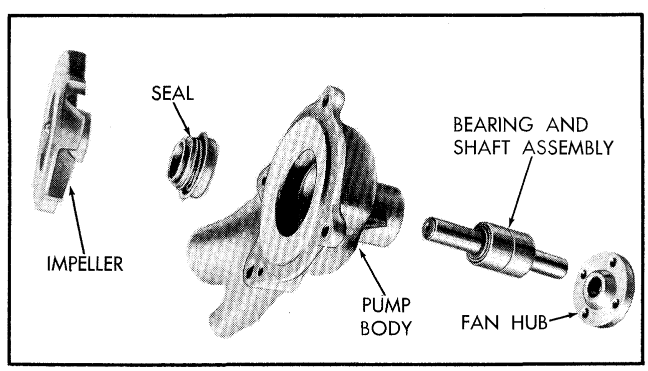



Fig. 6A-22 Water Pump - Exploded View (6 Cyl.)

6. Support pump in an arbor press as shown in Figure 5. Press shaft bearing and impeller assembly out of pump, applying pressure on the outer race of the shaft bearing only (Fig. 6A-20).

*CAUTION: Shaft and bearing assembly must not be pushed out of housing by applying force on shaft, or bearings will be damaged. Use a 7/8" deep socket or piece of tubing 1-1/8" O.D. Shaft and bearing assembly should be pressed out of rear of pump only.*

7. Support impeller with press plates J-9156 and J-6407. Press shaft with bearing out of impeller using 1/2" O.D. bar (Fig. 6A-21).

8. Wash all parts except pump shaft bearing in cleaning solvent, Figure 6A-22 shows the water pump disassembled.

*NOTE: Pump shaft bearing is permanently sealed and lubricated and should not be washed in cleaning solvent.*

9. Inspect shaft and bearing assembly for roughness or excessive end play. Remove any rust or scale from shaft with fine emery cloth. The bearing should be wrapped in cloth while this operation is performed to prevent emery dust from entering bearing.

10. Inspect seat for thrust washer on impeller for pit marks or scoring. If seat for thrust washer is scored or pitted, the impeller should be replaced.

### ASSEMBLY AND INSTALLATION

1. Install pump shaft and bearing assembly into pump body bearing bore, applying pressure to outer race until it is flush with front of pump body (Fig. 6A-23).

*CAUTION: Apply pressure to outer race only.*

2. Lightly coat O.D. of new seal with a sealing compound, mount in J-7818 and press into place with 1-1/4" socket or other suitable tool (Fig. 6A-24).

3. Press on fan hub. Check fan hub location, as this is ivery critical and has a definite bearing on fan belt operation, as shown in Figure 6A-25. Measure from pump body gasket surface to outer or front side of hub using tool J-9583.

4. Support pump on front or hub end of shaft and press on impeller. Press to obtain .010" to .035" clearance between impeller vanes and pump body (Fig. 6A-26).

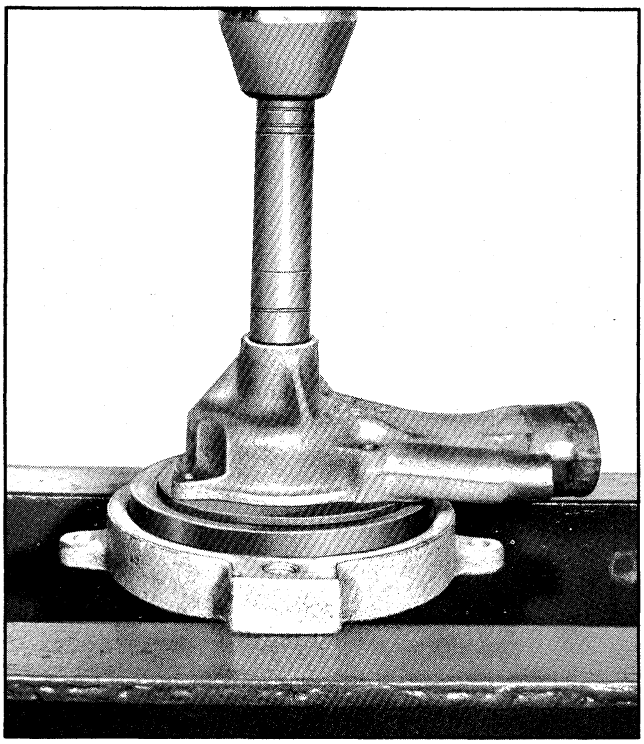


Fig. 6A-23 Pressing Pump Shaft and Bearing Into Pump Body Bearing Bore

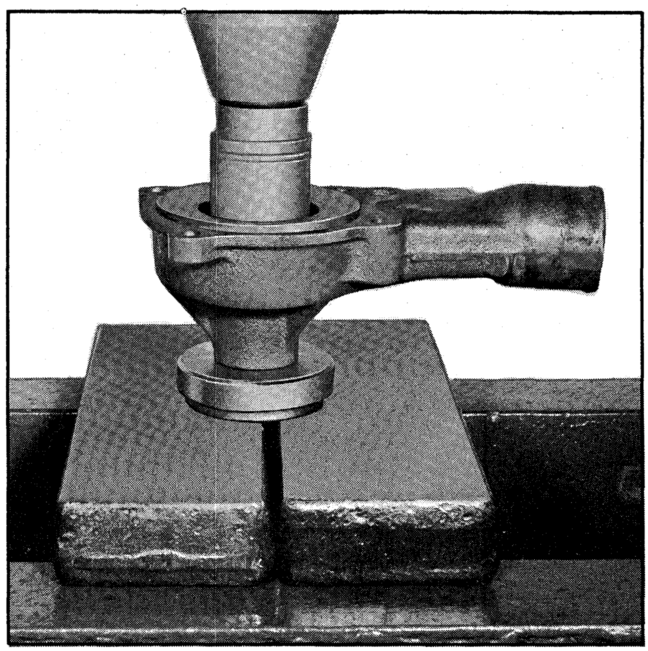


Fig. 6A-24 Installing Pump Seal

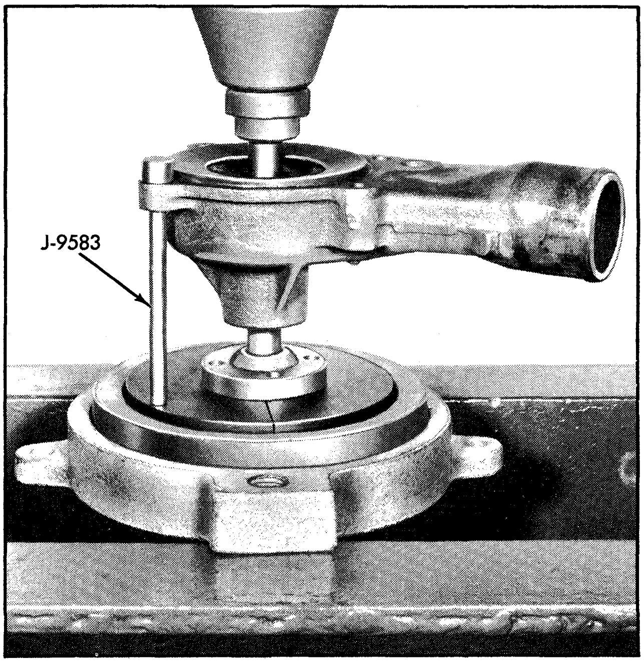



Fig. 6A-25 Installing Fan Hub Using Locating Tool J-9583

5. Install pump cover and gasket with a light coat of gasket sealer and install screws, then tighten all six diagonally.

6. Install pump pulley and fan on pump hub and tighten bolts securely.

7. Install pump assembly on cylinder block and tighten bolts securely. Use a new pump to block gasket. Install belt and adjust tension. See Fig. 6A-32.

8. Install hoses and fill cooling system.

#### WATER PUMP—V-8

NOTE: *Water pump is serviced only as an assembly.*

1. Drain radiator and engine block.

2. Loosen generator at adjusting strap and remove fan belt from fan pulley.

3. Remove fan and pulley.

4. Remove pump.

5. Install pump by reversing above steps. When pump is installed on engine, drain hole will be at

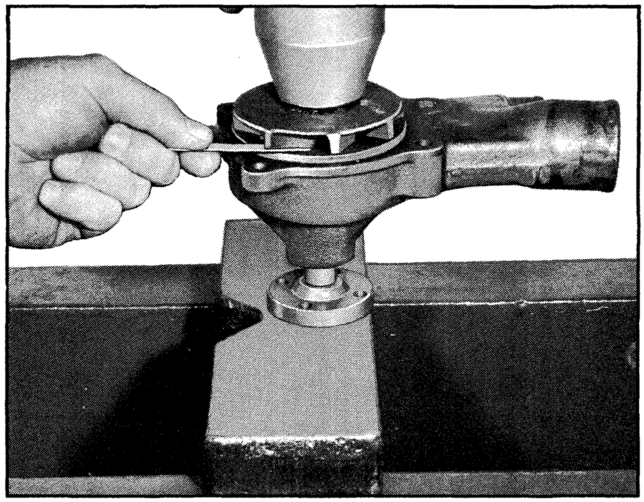


Fig. 6A-26 Checking Impeller to Pump Body Clearance

bottom. Tighten water pump attaching nuts to 15 lb. ft. torque. Adjust belt for proper tension on chart. (Fig. 6A-33)

#### RADIATOR—6 CYL. AND V-8—REMOVE AND REPLACE

1. Drain radiator.

2. Disconnect overflow, upper and lower radiator hoses.

3. Remove radiator fan shield (Fig. 6A-27).

4. Remove radiator.

5. To install radiator, reverse above procedure.

#### OIL FILTER 6 CYL. AND V-8—REMOVE AND REPLACE

Install a new oil filter at the first oil change and then each six months or each 6,000 miles thereafter, whichever occurs first.

1. Unscrew filter by hand from engine block base at right front (6 cyl. only) (Fig. 6A-28). Turn hex nut on bottom of filter counterclockwise to unscrew filter from base (V-8 only) (Fig. 6A-29).

NOTE: *This operation can be done from above on the 6 cyl.*

2. Wipe filter base with clean cloth.

3. Make sure filter base attaching screws are tight (V-8 only).

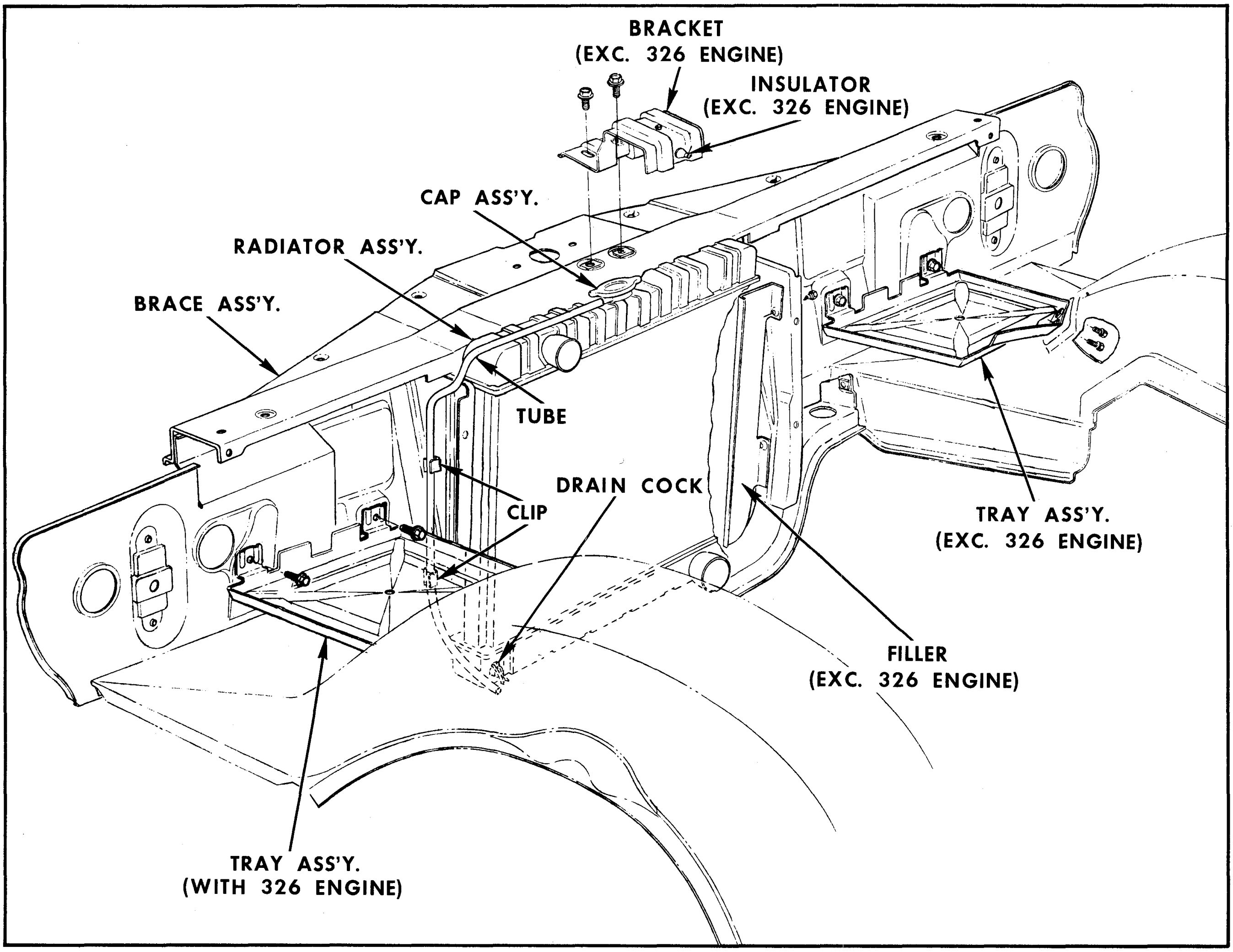



Fig. 6A-27 Radiator and Front End Sheet Metal

4. Apply light grease or oil on new gasket furnished in filter package and place gasket firmly in groove at open end of filter.

5. Hand tighten filter on hollow oil filter connector until gaskets contact filter base, then complete tightening with additional 2/3 turn of filter. Do not over tighten. Use care when tightening to prevent pinching of gasket. Do not use wrench to tighten filter.

6. Add oil to bring to "full mark" on dipstick.

7. Run engine and check for leaks at filter to base gaskets. Re-check crankcase oil level. If necessary, add oil to bring level to "full mark" on dipstick.

### *OIL FILTER CONNECTOR REMOVE AND REPLACE*

1. Remove oil filter by unscrewing from connector.

2. Unscrew connector from engine block using 1/2" Allen wrench (Fig. 6A-30).

3. Replace by reversing above procedure.

### *OIL FILTER BY-PASS VALVE ASSEMBLY REMOVE AND REPLACE*

1. Remove oil filter.

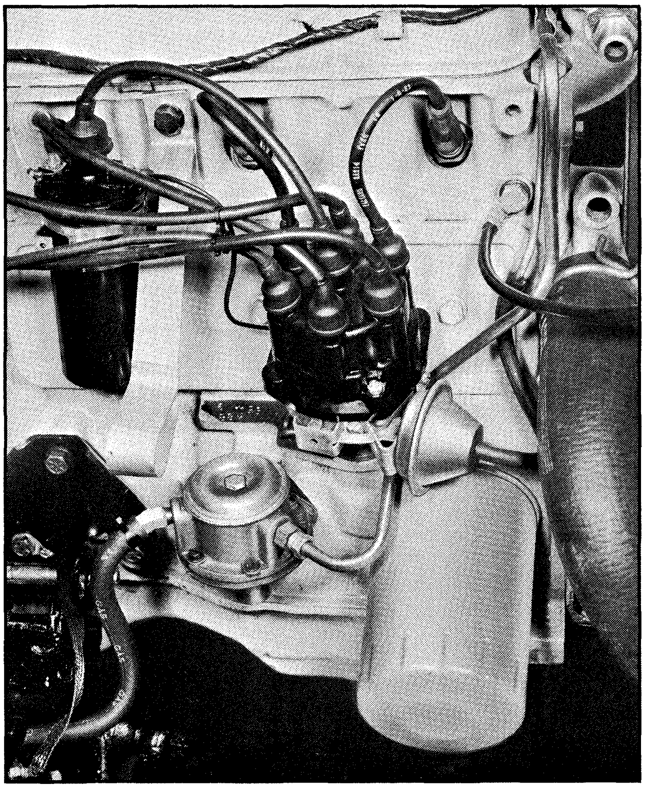


Fig. 6A-28 Oil Filter Location 6 Cyl.

2. Pry valve from engine block with large screw-driver (Fig. 6A-31).

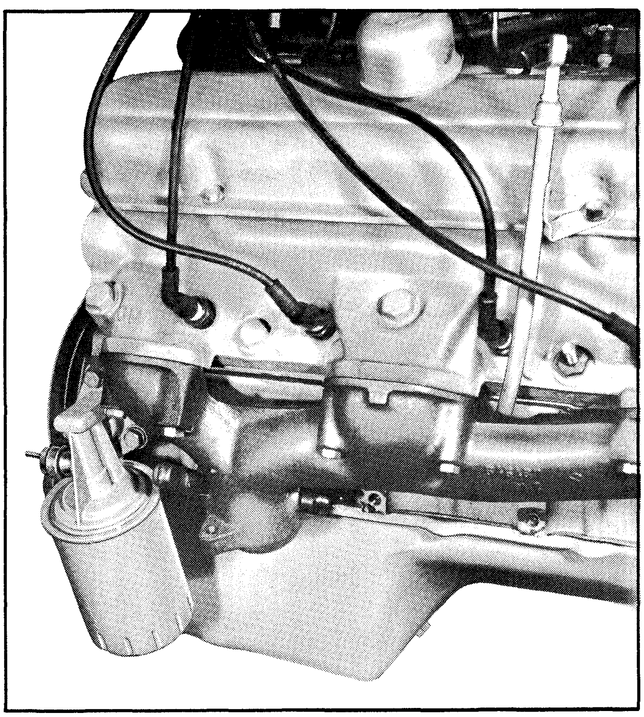


Fig. 6A-29 Oil Filter Location V-8

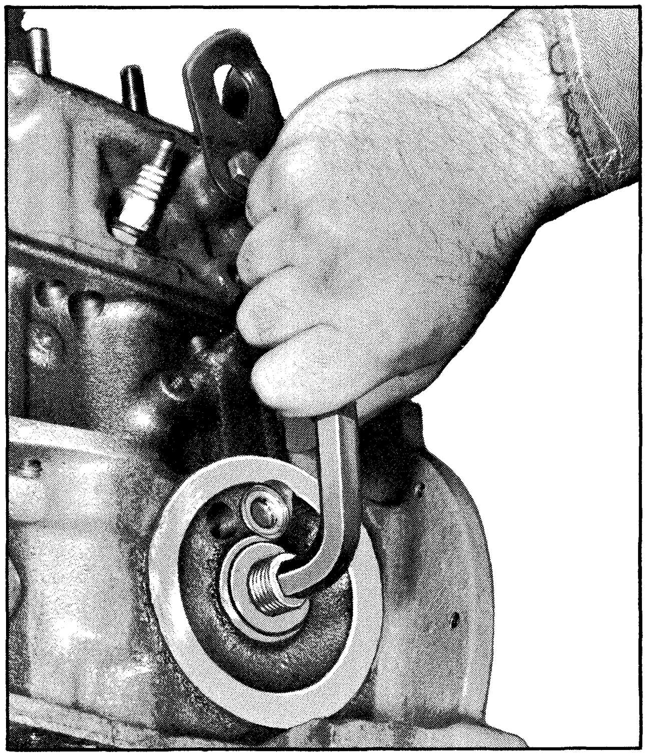


Fig. 6A-30 Removing Oil Filter Connector

3. Align new valve in opening and tap into position using suitable socket for driver.

4. Install oil filter.

***POSITIVE CRANKCASE VENTILATION SYSTEM***
***SEE GENERAL LUBRICATION SECTION***

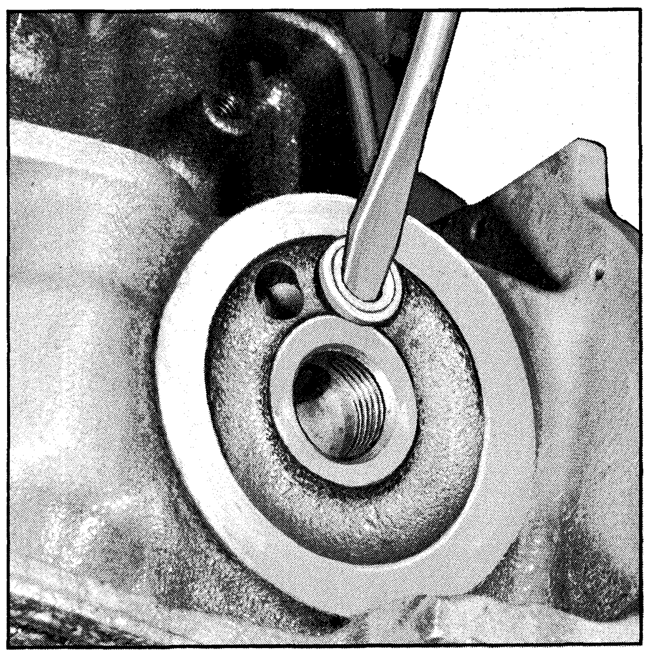


Fig. 6A-31 Removing Oil Filter By-Pass Valve

## TROUBLE DIAGNOSIS

| SYMPTOM | CAUSE |
|---|---|
| Cooling system loses water. | 1. Make sure owner is not trying to keep radiator filled to top, and is not filling while cold. The expansion and contraction of water during operation will cause level to drop to several inches below the top of the filler neck. Once the level becomes stabilized it will not change appreciably during operation. |
| | 2. If cooling system has excess soluble oil, drain and refill. |
| | 3. Check for leaks from radiator or hose connections, including heater. |
| | 4. Check for crack in block. Pull engine oil dipstick to check for water in crankcase. |
| | 5. Remove rocker arm cover and check for cracked cylinder head. |
| | 6. Remove cylinder head and check gasket. While head is off, check for crack in head or block. |
| Buzzing noise from radiator cap. | This is caused by the relieving of excessive pressure when radiator boils. Check causes of overheating. |
| Overheating (coolant actually boils). | 1. Check engine thermostat. |
| | 2. Check for driving conditions which may cause overheating. Prolonged idling, start and stop driving in long lines of traffic on hot days, climbing steep grades on hot days, etc. will occasionally cause coolant to boil. |
| | 3. Check engine operation to make sure tune-up is not needed. Timing retarded past TDC may cause overheating. NOTE: Timing must be set with vacuum advance line disconnected. |
| | 4. Check fan belt for excessive looseness. |
| | 5. Clean debris from radiator. |
| | 6. Clean cooling system. |
| | 7. Remove cylinder head and check water passages in head and block for obstructions. |

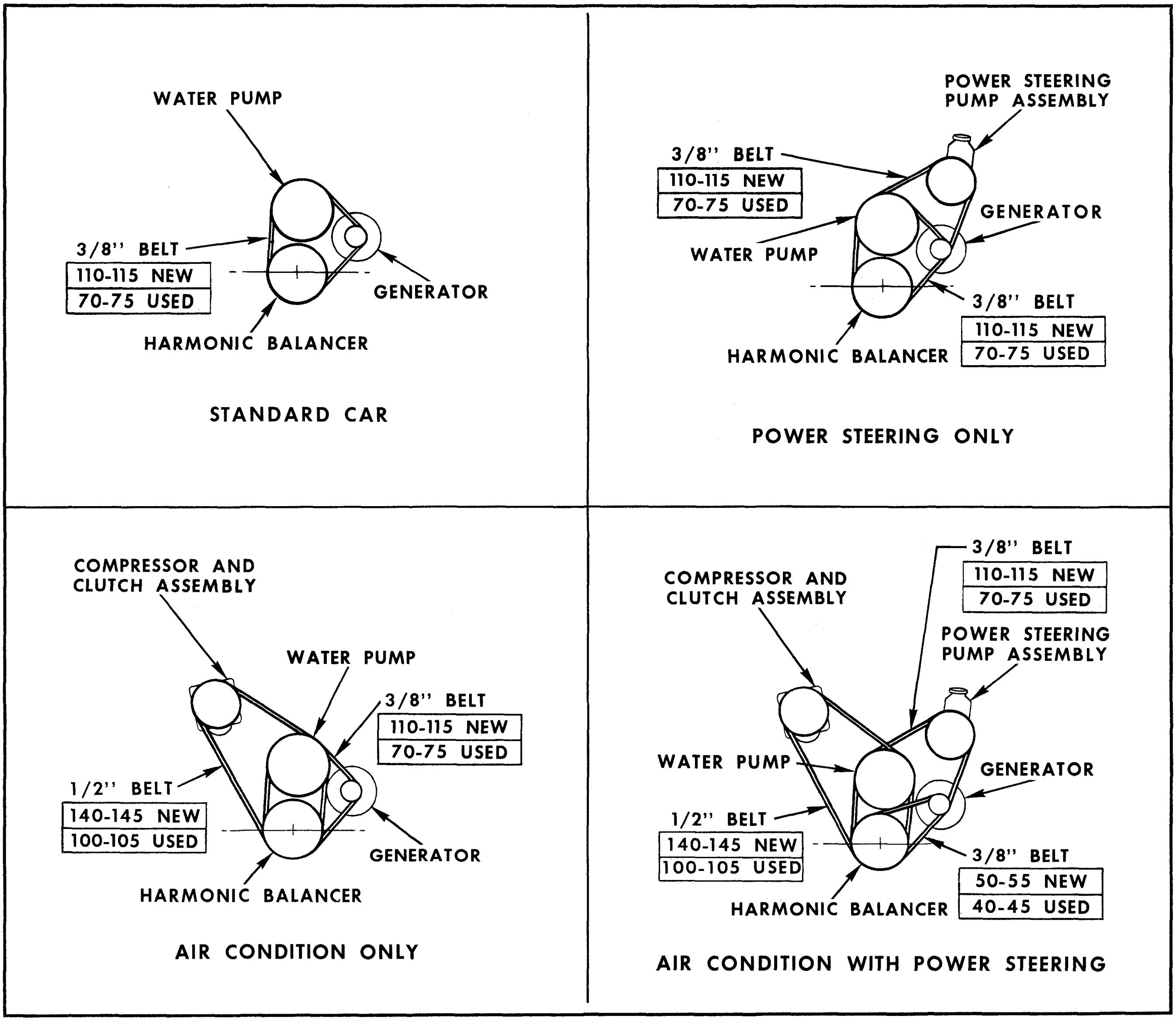



Fig. 6A-32 Belt and Pulley Diagrams - Six Cylinder Engine

## DRIVE BELTS FOR PONTIAC TEMPEST ENGINE AND ACCESSORY DRIVE COMBINATIONS

| Belt Width | Belt Name | Burroughs Gauge New | Burroughs Gauge Used |
|---|---|---|---|
| 3/8" | Water Pump and Alternator Belt (6 cyl. and V-8 Engine) | 110-115 Lbs. | 70-75 Lbs. |
| 3/8" | Power Steering Pump Belt (6 cyl. and V-8 Engines) | 110-115 Lbs. | 70-75 Lbs. |
| 1/2" | Air Conditioning Comp. Drive Belt (6 cyl. and V-8 Engines) | 140-145 Lbs. | 100-105 Lbs. |

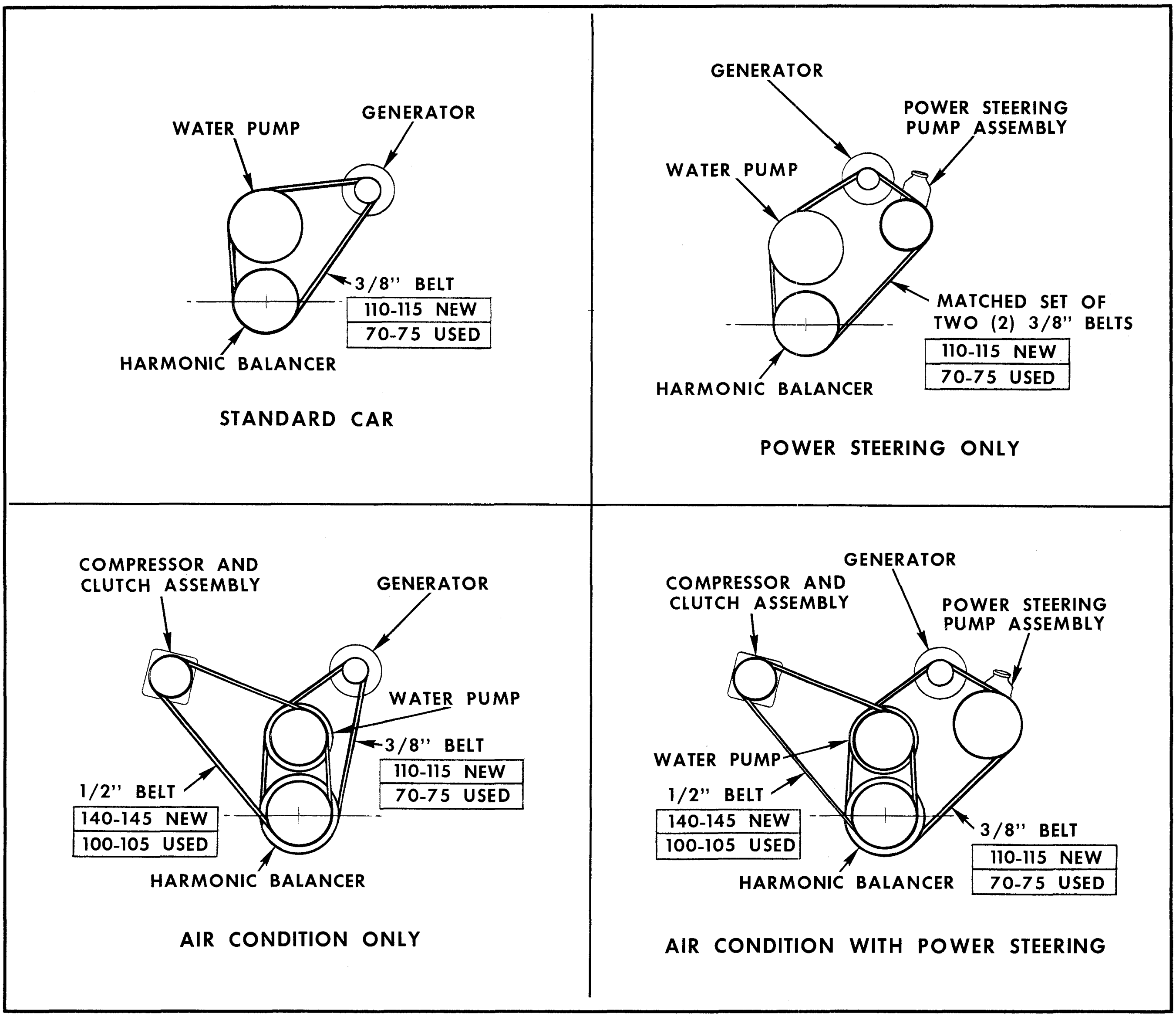



Fig. 6A-33 Belt and Pulley Diagrams - V-8 Engine

## SPECIFICATIONS

### COOLING SYSTEM

| | |
|---|---|
| Type | Pressure with vent |
| Operating Pressure | 15 psi |
| Pump Type | Centrifugal |
| Pump and Fan Drive | V-Belt |
| Pump Bearings | Sealed Ball Bearings |
| Radiator | Tube and Center |
| Core Area | 6 cyl. Std. 323 |
| | 6 cyl. A/C 357 |
| | V-8 391 sq. in. |

***COOLING SYSTEM (Continued)***

Thermostat . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 180°

Fan Diameter—Standard . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 6 cyl.--17.62" V-8—17"

Fan Diameter—w/Air Conditioning

6 cyl. Engine . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 18"

V-8 Engine (w/fan clutch) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 18"

Number of Blades—Standard Fan . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4

Number of Blades—Air Conditioning Fan . . . . . . . . . . . . . . . . . . . . . . . . . . 7

Cooling System Capacity 6 cyl.

With Heater . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 11.28 qts.

Without Heater . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10.12 qts.

With Air Conditioning . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Cooling System Capacity V-8 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 20.5 qts.

***LUBRICATION***

Type . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Pressure

Oil Pressure . . . . . . . . . . . . . . . . . . . . . . . . . . . 6 cyl. . . . . . 45 psi @ 2000 rpm
V-8 . . . . . 30-40 psi @ 2600 rpm

Lubricant Capacity When Refilling . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4 qts.
(5 qts. if filter element is changed)

Oil Pump Type . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Spur Gear

**TEMPEST RADIATOR USAGE**

| MODEL | CODE* | CORE THICKNESS |
|---|---|---|
| 215 6 Cyl. Engine | 151 | 1.26" |
| 215 6 Cyl. Engine with A/C | 152 | 2.00" |
| 326 V-8 Engine SM | 155 | 2.00" |
| 326 V-8 Engine Auto. | 153 | 2.00" |
| 326 V-8 Engine with A/C | 157 | 2.00" |
| 326 H.O. V-8 Engine | 156 | 2.00" |
| 326 H.O. V-8 Engine with A/C | 158 | 2.62" |

*Code number is stamped on inside upper right corner of radiator assembly.

# ENGINE FUEL

## CONTENTS OF THIS SECTION



## CARBURETOR AIR CLEANER AND SILENCER

An oiled polyurethane filter element is standard equipment on the 215 6 cyl. and 326 H.O. V-8 engines and is heavy duty equipment on the 326 V-8.

An oiled aluminum mesh filter element is standard equipment on the 326 V-8.

For servicing filter elements see "General Lubrication", Section 2.

## HEAT CONTROL VALVE (Fig. 6B-1 & 6B-2)

A thermostatically controlled valve in the outlet of the exhaust manifold on the 6 cyl. and V-8 engines directs the passage of exhaust gases to the intake manifold when the engine is cold.

In the 6 cyl. engine, exhaust gases will then pass through the hollow rectangular housing beneath the intake manifold to warm the incoming fuel mixture.

In the V-8 engine, exhaust gases will pass through the intake manifold crossover passage beneath the carburetor and heat the fuel mixture. From the intake manifold the exhaust gases pass through the left exhaust pipe and out of the system.

As the engine warms up, the thermostatic heat control valve opens allowing all gases to be exhausted without heating the intake manifold.

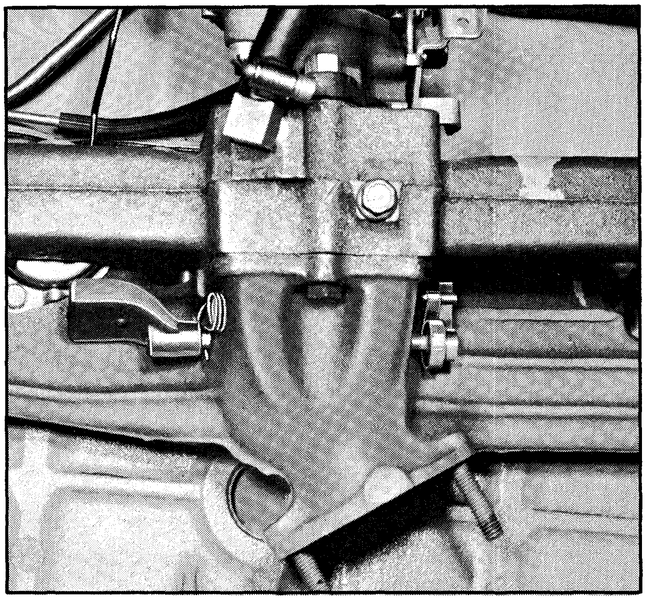


Fig. 6B-1 Heat Control Valve 6 Cyl.

## THROTTLE RETURN CHECK *(Fig. 6B-3)*

The throttle return check is mounted on the carburetor and is designed to open the throttle valves to increase engine speed slightly and prevent stalling when engine vacuum drops. It also acts to retard throttle when the driver suddenly takes his foot off the accelerator pedal. The throttle return check is standard on Tempest V-8 engines with automatic transmissions.

### *THROTTLE RETURN CHECK ADJUSTMENT (AUTOMATIC TRANS.)*

1. Set hot idle and mixture adjustment to specifications.

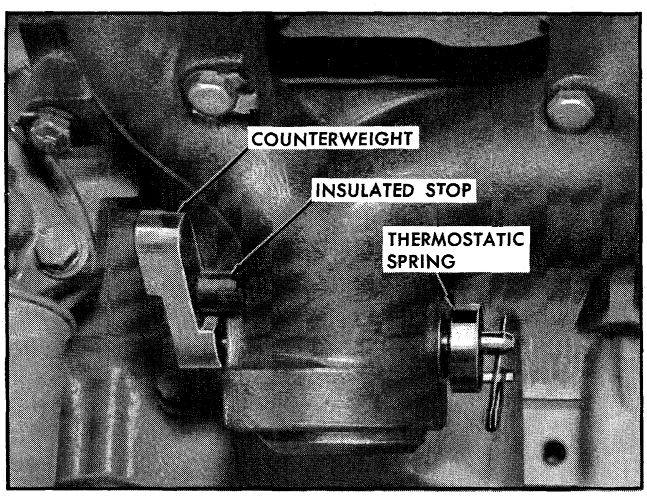



Fig. 6B-2 Heat Control Valve V-8

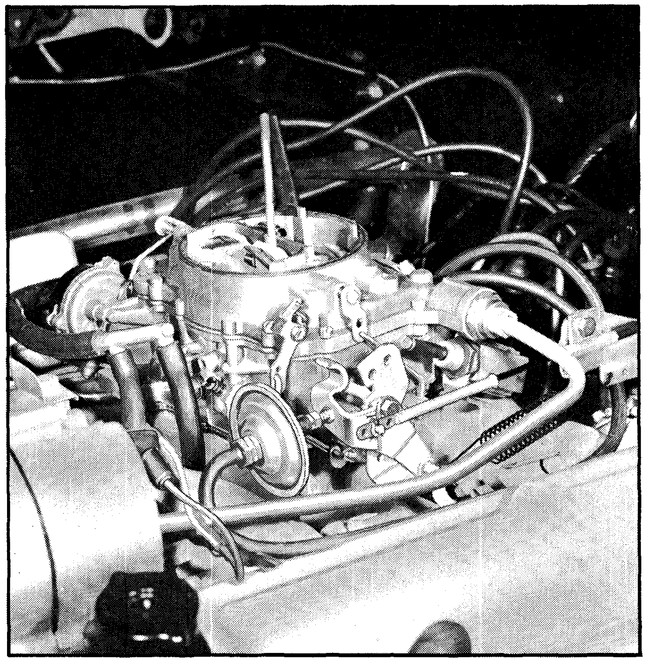


Fig. 6B-3 Throttle Return Check

2. Place transmission in neutral.

3. With engine running, disconnect vacuum hose from throttle return check and plug open end of vacuum hose.

4. Adjust the contact screw of the throttle return check to obtain speed of 1030-1080 rpm.

*CAUTION: Hold sleeve next to diaphragm from turning while adjusting contact screw.*

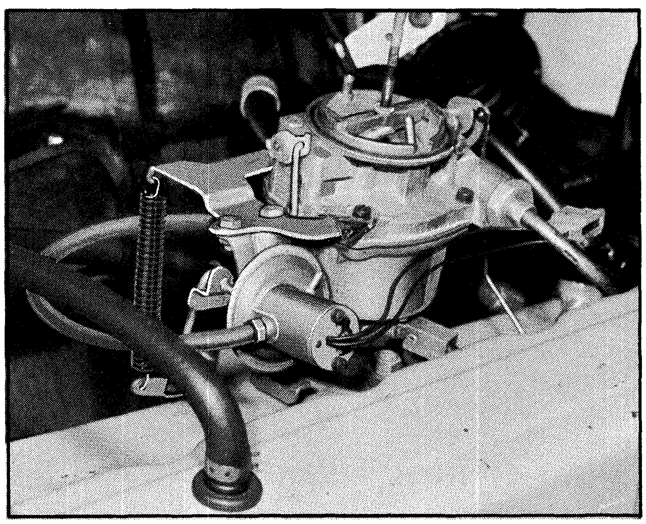


Fig. 6B-4 Idle Speed Up Device

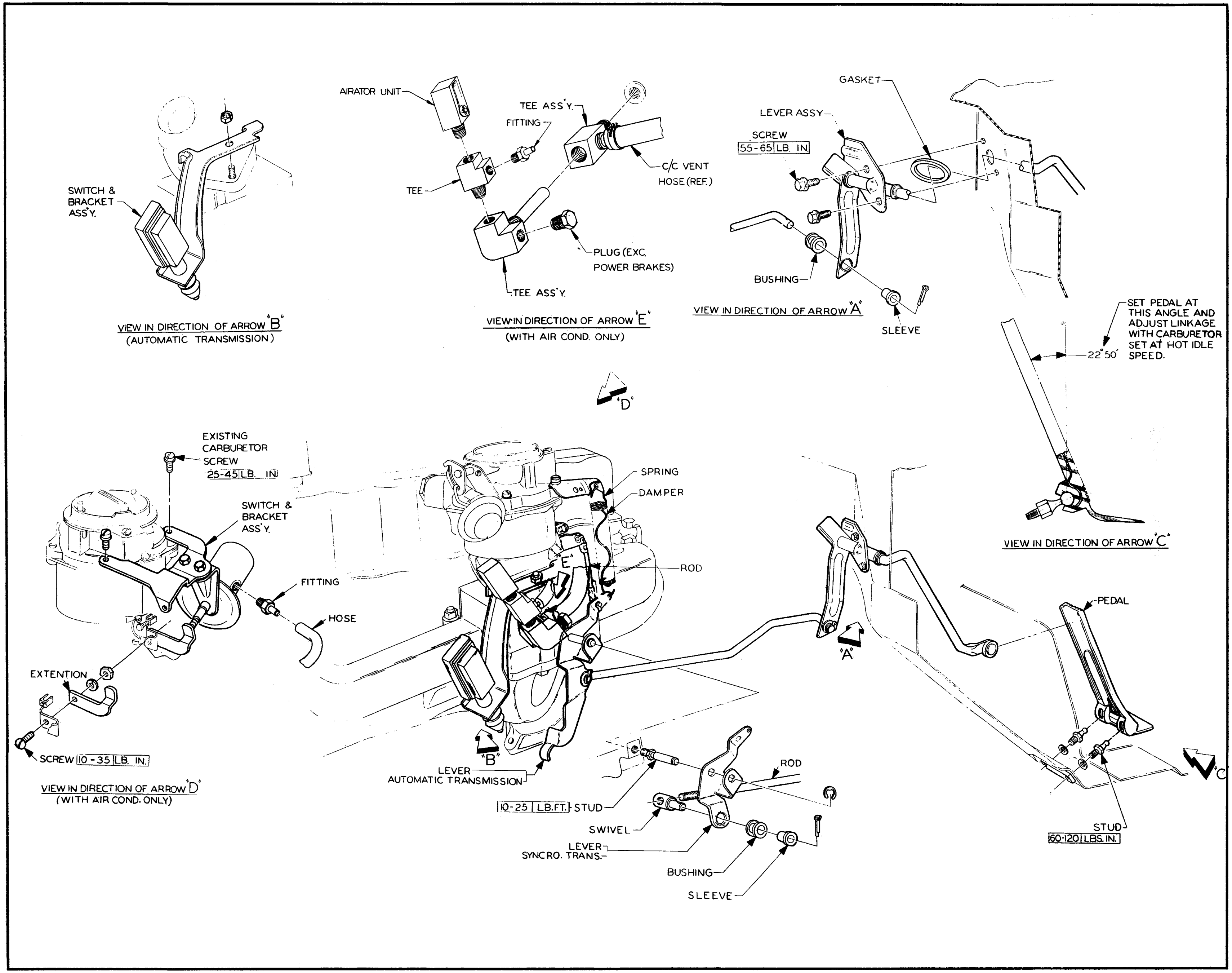



Fig. 6B-5 Accelerator Linkage 6 Cyl.

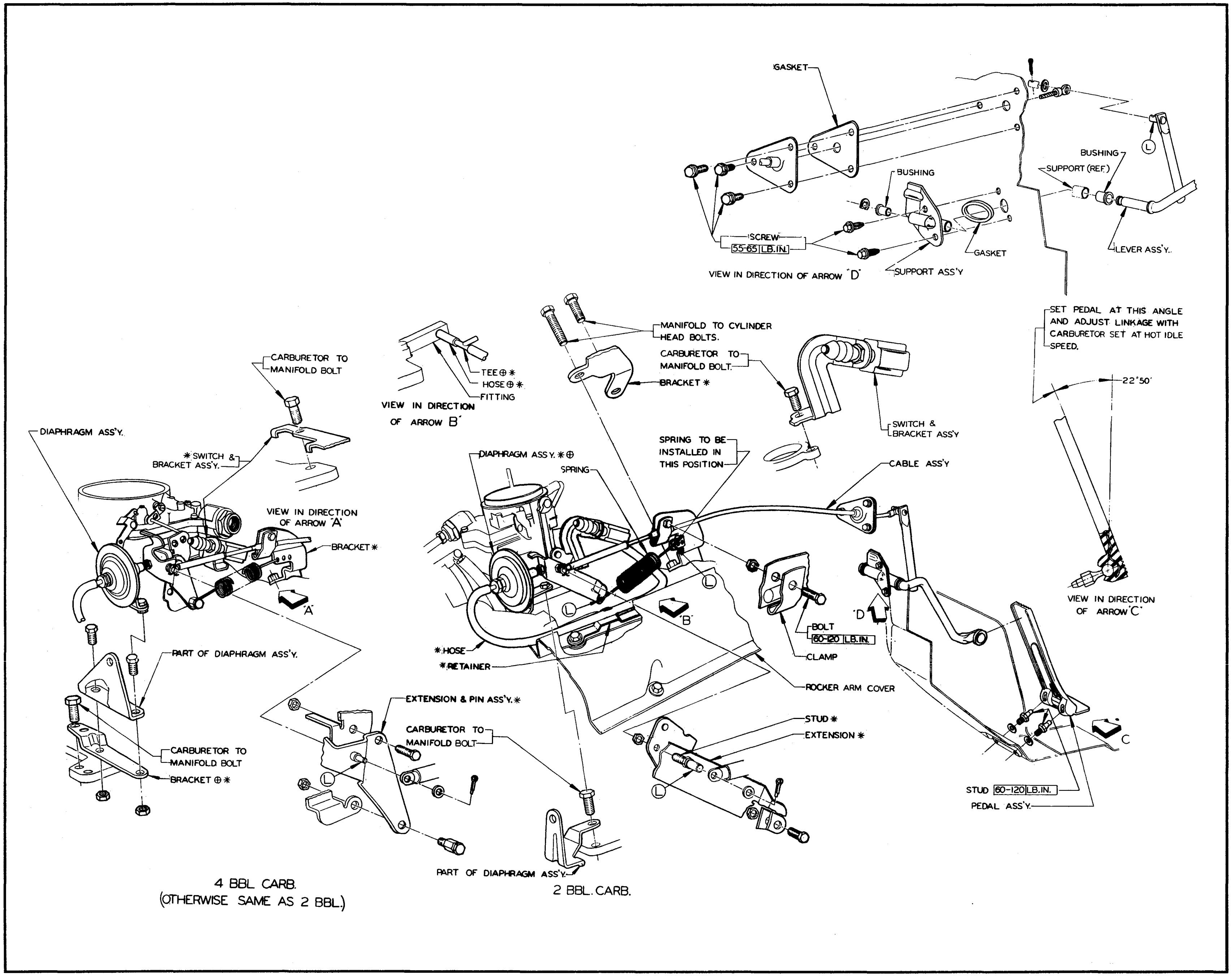



Fig. 6B-6 Accelerator Linkage V-8

## IDLE SPEED-UP DEVICE

The idle speed-up device (Fig. 6B-4) is standard on 6 cyl. engines with air conditioning. It consists of a solenoid (connected by two wires to the air conditioning compressor) and a vacuum diaphragm similar to a throttle return check diaphragm. The mechanism increases idle speed when air conditioning is on and acts as a throttle return check when the air conditioning is off. When the air conditioning compressor is operating, the solenoid opens a release valve, decreasing diaphragm vacuum, thus causing the diaphragm plunger to partially open the carburetor throttle valve. The solenoid is inoperative when the air conditioning is off.

### *IDLE SPEED-UP DEVICE ADJUSTMENT*

Set hot idle speed and mixture to specification and leave automatic transmission in drive and synchromesh transmission in neutral. Turn on air conditioning for maximum cooling and adjust diaphragm screw to obtain engine speed as follows:

Automatic in Drive, air conditioning on, hot idle compensator closed - 480-500 rpm.

Synchromesh in Neutral, air conditioning on, hot idle compensator closed - 580-600 rpm.

*CAUTION: Hold sleeve next to diaphragm from turning while adjusting screw.*

### *HOT IDLE COMPENSATOR*

The hot idle compensator used on six cylinder engines with air conditioning is attached to the tee fitting in the intake manifold. It consists of a bi-metal strip, a valve and housing. It functions as follows:

As engine and underhood temperatures rise to a predetermined value, the bi-mteal strip lifts the valve off its seat. This allows fresh air to enter the manifold below the throttle valves and off-set rich mixtures, due to fuel vapors, which can cause rough idle and stalling.

When underhood temperatures return to normal, the bi-metal strip will lower and the compensator valve will close and normal idle operation will resume.

*NOTE: No adjustments are necessary on the idle compensator. The compensator valve must be closed while adjusting engine idle.*

## ACCELERATOR LINKAGE ADJUSTMENT

1. Check accelerator pedal height. If necessary, adjust linkage (Fig. 6B-5-6) to obtain correct height.

2. Depress accelerator to floor and check to see that carburetor throttle valves are wide open.

# ROCHESTER BV CARBURETORS

## 6 CYL. ENGINE
## (1 9/16 Throttle Bore)

### GENERAL DESCRIPTION

The Rochester Model BV carburetor is a single barrel, downdraft model with provision for automatic choke mounted on the exhaust manifold, and is used on the 1964 Tempest, 215 cu. in. engine, for both automatic transmission and synchromesh applications (Fig. 6B-7).

| Carburetor No. | Used On |
|---|---|
| 7024164 | 6 cyl. Synchromesh Transmission |
| 7024166 | 6 cyl. Automatic Transmission |

The Model BV carburetor incorporates several distinct features. It has a concentric float bowl, which completely surrounds the main bore of the carburetor. The design of the float bowl, in conjunction with the centrally located discharge nozzle, prevents fuel loss on inclined roads. Regardless of the angle the car assumes, the fuel level is below the nozzle spill point at all times.

Another feature of the carburetor is the unique design of the main well assembly. This assembly contains the main metering jet and power valve. It is attached to the carburetor air horn and is suspended in the float bowl. Engine heat cannot be directly transmitted from the float bowl into the main well area.

On the Model BV carburetor the choke thermostatic coil is located on the exhaust manifold and is connected directly to the choke valve shaft by a connecting rod (Fig. 6B-8). The exhaust mounted choke coil provides excellent choke response to supply the correct fuel mixtures to the engine during the warm-up period. A vacuum diaphragm unit mounted on the carburetor air horn opens the choke valve, just after starting, to a point where the cold engine will run without loading or stalling (Fig. 6B-8).

The Model BV carburetor incorporates the six systems of carburetion: Float, Idle, Main Metering, Power, Pump and Choke.

#### *FLOAT SYSTEM (Fig. 6B-9)*

The Model BV carburetor has the conventional needle and seat to control fuel level in the float bowl. With the concentric float bowl design, dual floats

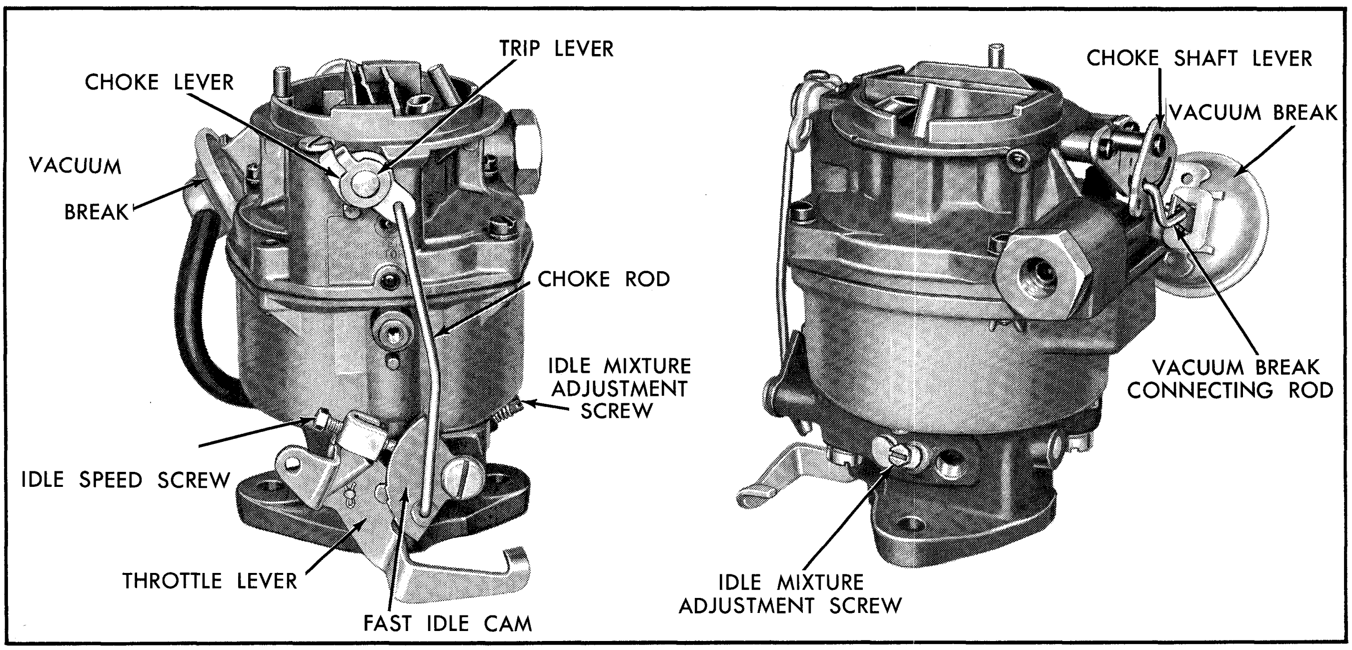



Fig. 6B-7 Rochester BV Carburetors

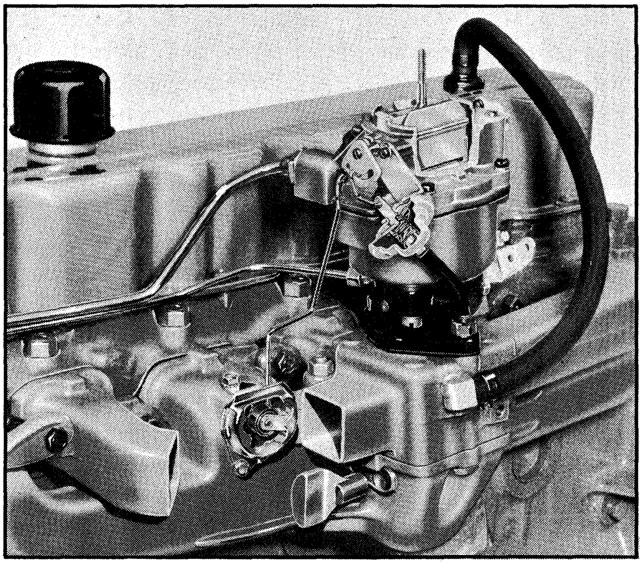


Fig. 6B-8 Thermostatic Coil and Connecting Rod

are used to maintain a constant fuel level at all times. This is important because fuel level directly affects the air/fuel ratio by determining the distance the fuel must rise to enter the nozzle bar for the idle and main discharge systems. A low fuel level will produce too lean a mixture, while a high fuel level will produce a richer mixture and possibly cause flooding. The float bowl is designed so that the fuel is centrally located around the main well, so that efficient carburetor metering can be maintained under all engine operating conditions.

As shown, components of the float system are the inlet fitting and gasket, fuel filter and gasket, pressure relief spring, needle valve and seat, and the

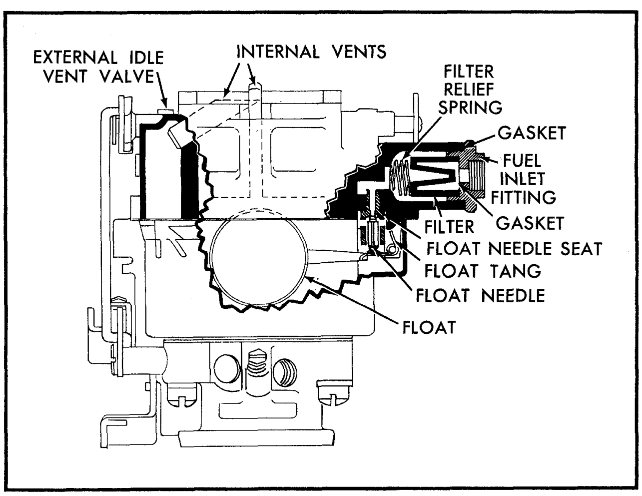



Fig. 6B-9 Float System

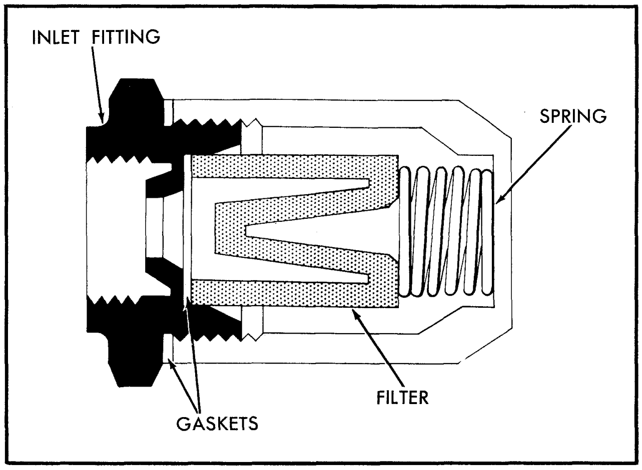



Fig. 6B-10 Fuel Inlet Components

float. It should be noted that the fuel filter at the fuel line connection, behind the fuel inlet nut, is spring loaded (Fig. 6B-10). This provides a pressure relief feature so that in the event the filter should plug, the restriction would cause fuel pump pressure to overcome the spring and allow fuel to by-pass the filter.

When the float bowl fuel level is low, the float drops downward and allows the needle to come off its seat. This allows fuel to flow into the float bowl from the engine fuel pump supply. The fuel intake continues until the fuel level reaches the correct height set by the float level adjustment.

At this point, the needle again seats and fuel intake ceases. While the engine is running the float needle is continuously unseating an amount proportional to the rate of fuel consumption by the engine. The float drop tang at the rear of the float hanger prevents the float needle from dropping out of the seat during disassembly and assembly operations.

The carburetor is internally vented by three vent tubes located inside the air horn bore just beneath the air cleaner. The air vents balance the air pressure from beneath the air cleaner to the fuel in the float bowl. The amount of fuel metered by the carburetor is dependent upon the air pressure in the float bowl causing fuel to flow. By locating the vents below the air cleaner, or internally, the carburetor automatically compensates for air cleaner restriction, since the same pressure causing air to flow will also be causing fuel to flow.

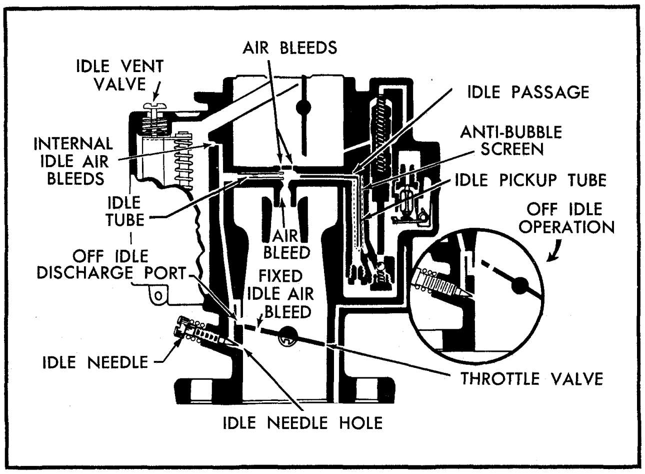



Fig. 6B-11 Idle System

### *IDLE SYSTEM (Fig. 6B-11)*

At idle speeds, the throttle valve is nearly closed so there is not enough air flow through the venturi to lift fuel from the float bowl. Therefore, to supply enough fuel for idle and off idle requirements, a separate system is used called the idle system. To make fuel flow, manifold vacuum is applied directly to the fuel in the bowl from the idle needle hole and off idle port as the throttle valve is gradually opened. The idle system consists of the idle pick up tube, idle tube, idle passages, idle air bleed, idle mixture adjustment needle, idle discharge holes, and an idle speed adjustment screw.

A fixed air bleed drilled through the throttle valve acts as a deterrent to stalling due to gum formation at the throttle valve. The fixed idle air bleed maintains a constant idle air flow for part of the idle air requirements, while the idle speed adjusting screw regulates the remainder of the idle air. The engine idle speed can be adjusted by the idle speed adjusting screw.

The idle mixture needle hole is in the high vacuum area below the throttle valve while the fuel bowl is vented to atmospheric pressure. Vacuum can be called lack of pressure, so a high vacuum area can be spoken of as an area of low pressure. There is considerable pressure difference between the normal atmospheric pressure on the fuel in the bowl and the low pressure (or high vacuum) at the idle mixture needle hole. The air/fuel mixture will be forced by atmospheric pressure to occupy any low pressure area. Due to the difference in pressure, the fuel will flow from the fuel bowl to the engine manifold.

Atmospheric pressure acting on the fuel in the float bowl, forces fuel through the main metering jet into the main well. The fuel then passes through an anti-bubble screen in the main well which removes any vapor bubbles that might form during hot engine idle to disrupt carburetor metering. The fuel then travels up through the idle pick up tube and then through the cross bar channel in the air horn. Air is then bled into the idle fuel at the center of the cross bar through the two top bleeds and nozzle hole. The air/fuel mixture then is picked up by the horizontal idle tube in the cross bar and metered through a calibrated restriction, then passes on into the vertical down channel where it is further bled with air by an internal idle air bleed in the vertical channel in the top of the float chamber. The fuel then travels downward, past the off idle discharge port where more air is picked up to mix with the fuel mixture and it then passes out the idle needle port below the throttle valve. Here the fuel mixture mixes with air coming past the slightly open throttle valves and passes on into the engine as a combustible idle mixture.

The idle air bleed passage in top of the float chamber serves a dual purpose. When the engine is idling or first stopped, the fuel in the carburetor is heated by warm air rising from engine and tends to form vapor in the idle system. A bleed to the float chamber permits the idle system to vent, thereby, preventing hard hot starting and rough idling due to vapor build-up in the idle system. The air bleed also assists in removing fuel vapors from the fuel bowl by utilizing these vapors during hot engine idle.

An external idle vent valve located on top of the air horn is operated by the pump plunger rod and vents fuel vapors from the float bowl during hot engine idle and hot "soak". This feature greatly improves hot engine idle and starting. The idle vent automatically closes after the throttle valve has moved from idle position into the part throttle range, at which point the carburetor returns to an internal balance.

Except for the idle mixture adjustment needle, the idle system is specifically calibrated for low engine speeds.

### *OFF-IDLE OPERATION (see inset Fig. 6B-11)*

As the throttle valve is opened slightly and engine speed increases, extra fuel is needed to combine with the additional air going by the throttle valve. This fuel is supplied by the off-idle discharge port.

This supplies additional fuel to the engine until air velocity is high enough in the venturi area to obtain efficient metering from the main metering system.

Further opening of the throttle valve causes increased air flow through the carburetor bore which causes pressure drop in the small venturi sufficient to cause fuel delivery from the main nozzle. It should be remembered, however, that idle port discharge does not cease at this transfer point, but rather diminishes as main nozzle discharge increases. Thus, the two systems interact and produce a smooth air/fuel flow at all engine speeds.

### *MAIN METERING SYSTEM (Fig. 6B-12)*

As mentioned, once air flow is sufficient to create enough pressure differential in the small venturi for fuel flow to start from the main nozzle, the transfer point has been reached and the carburetor starts metering from the main metering system.

Since the low pressure point is now in the small venturi area, fuel will be forced from the fuel bowl through the main metering system into the venturi, as follows:

The fuel passes through the main metering jet into the main well where it rises in the main well tube. The fuel continues up the main well tube to the horizontal cross bar in the air horn and through the cross bar to the main discharge nozzle. At this point, air is bled into the fuel by the two air bleeds in the top of the cross bar channel. The mixture is then discharged through the main discharge nozzle into the small venturi. Here, the air/fuel mixture mixes with additional air and moves on to the bore of the carburetor and into the intake manifold.

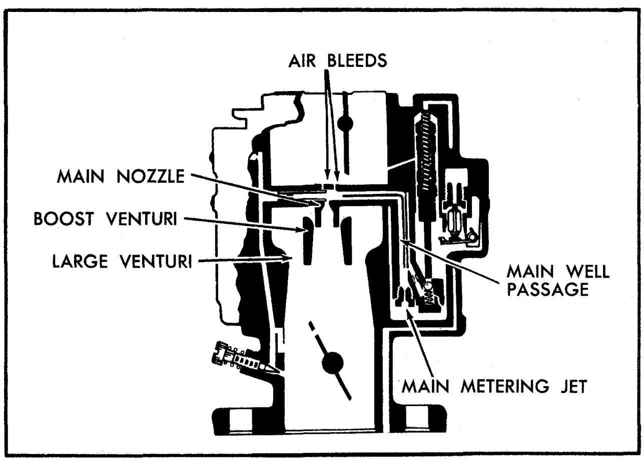



Fig. 6B-12 Main Metering System

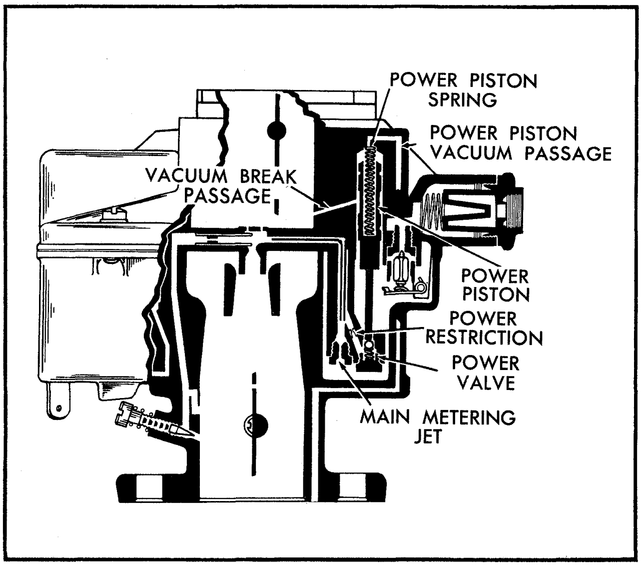



Fig. 6B-13 Power System

The calibration of the main metering jet and air bleeds in the cross bar maintain economical air/fuel ratios throughout the main metering or cruising range. Therefore, no adjustments are necessary in the main metering system.

### *POWER SYSTEM (Fig. 6B-13)*

A vacuum operated power system is used in the carburetor to provide additional fuel for sustained high speed operation or increased road load power. A direct manifold vacuum passage within the carburetor to the engine intake manifold connects to the power piston. Under heavy engine load the manifold vacuum drops, thereby, decreasing the vacuum pull on the power piston and the piston is forced downward by a spring above the power piston. The power piston spring is specifically calibrated to force the power piston downward at a given manifold vacuum.

The downward motion of the power piston unseats the spring loaded ball in the power valve assembly. Fuel passes around the ball in the base of the main well support. The calibrated power restriction meters the fuel prior to joining the fuel from the main metering jet. Conversely, as the manifold vacuum rises above a specific point, the power piston is drawn up immediately to the up position and the spring loaded ball of the power valve closes, returning the carburetor to the economical part throttle mixture. There is no adjustment required for the power system.

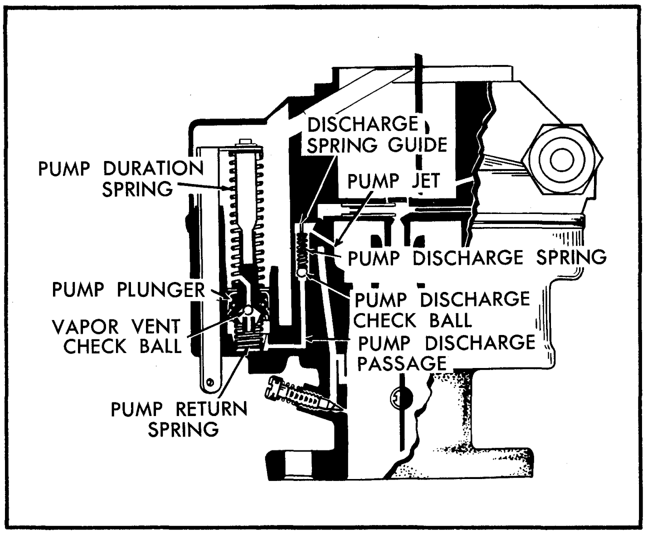



Fig. 6B-14 Pump System

The relief passage which is drilled from the bore of the air horn to the power piston chamber serves to relieve any vacuum build-up around the piston diameter. This vacuum, if unrelieved, will draw fuel vapors from the float bowl past the piston and down the vacuum passage into the manifold, resulting in an overly rich mixture.

## PUMP SYSTEM (Fig. 6B-14)

Extra fuel for smooth, quick acceleration is supplied by a double spring pump plunger. Rapid opening of the throttle valve, as in the case where accelerating from low speed, causes an immediate increase in air velocity in the carburetor venturi and bore area. Since fuel is heavier than air, it requires a short period of time to "catch up" with the air flow. To avoid a leanness during this momentary lag, the accelerator pump furnishes a quantity of liquid fuel sprayed into the air stream to mix with the incoming air and maintain the proper air/fuel mixture.

The pump is operated by the combined action of two springs which are calibrated to move the plunger in such a manner that a sustained charge of fuel is delivered for smooth acceleration. The pump is attached by linkage to the throttle lever. When the throttle valves are closed, the pump plunger moves upward in its cylinder allowing fuel to flow from the float bowl through a slot in the side of the pump well, into the pump well, past the plunger head, through the vapor check ball and on into the bottom of the pump well. The pump discharge ball is seated at this time to prevent fuel and air from draining into the pump well from the pump discharge passage.

When the pump plunger is moved downward for acceleration, the force of the stroke seats the vapor check ball in the pump plunger head to prevent fuel flow back into the float bowl. Downward motion of the pump plunger forces fuel up through the discharge passage and lifts the pump discharge check ball from its seat and then passes on through the pump jets into the venturi area where it strikes the side of the boost venturi atomizing the fuel with the air and is delivered to the engine.

The check ball, inside the pump plunger head, vents any vapors which might form in the pump well during periods of "hot idle" or "hot soak". The check ball is designed so that it can move up and down in its passage. When the pump plunger is not in operation, the vapor vent check ball drops off its seat and vents any vapors which might form in the pump well below the pump plunger head, out through the hole in the pump plunger into the fuel bowl area and out the air horn vents.

## CHOKE SYSTEM (Fig. 6B-15)

The purpose of the choke system is to provide a richer mixture for cold engine starting and operation. Mixture enrichment is necessary because fuel vapor has a tendency to condense on cold engine

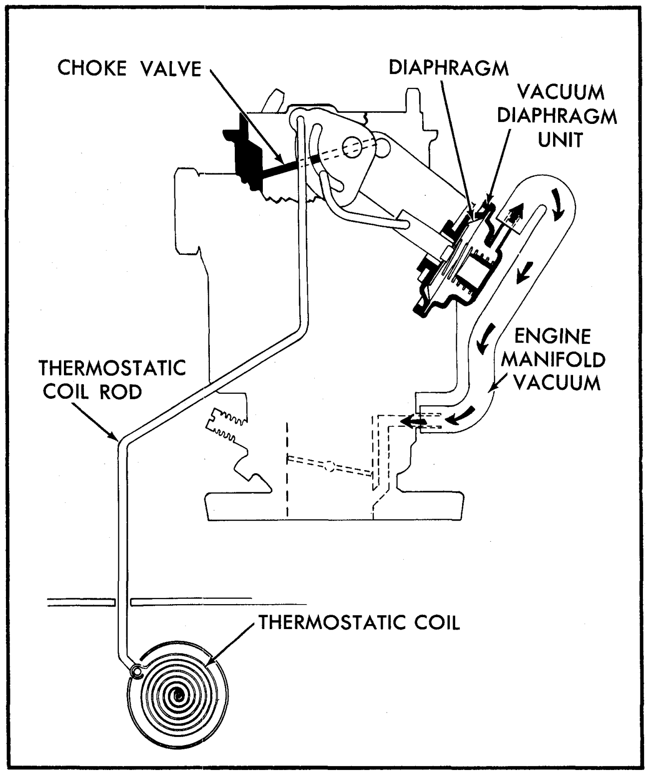



Fig. 6B-15 Choke System

parts, such as the inside area of the intake manifold and cylinder head, thereby, decreasing the amount of combustible mixture available in the engine cylinder.

The choke system consists of a choke valve located in the carburetor air horn, a vacuum break diaphragm unit, fast idle cam, choke linkage and a thermostatic coil which will be located on the engine exhaust manifold. The thermostatic coil is connected to the choke valve by a rod. The choke operation is controlled by a combination of intake manifold vacuum, the offset choke valve, atmospheric temperature and exhaust manifold heat.

The thermostatic coil located on the engine manifold is calibrated to hold the choke valve closed when the engine is cold. When starting the engine, air velocity against the offset choke valve causes the valve to open slightly, against the torque of the thermostatic coil. When the engine is started and running, intake manifold vacuum applied to the vacuum diaphragm unit mounted on the carburetor air horn will open the choke valve to a point where the engine will continue to run without loading or stalling. The choke valve will remain in this position until the engine begins to warm up and the heat from the engine manifold warms up the thermostatic coil to relax its tension and allows the choke valve to gradually open. Opening of the choke valve is controlled directly by air flow through the carburetor air horn past the offset choke valve and manifold heat acting upon the thermostatic coil.

During warm-up it is necessary to provide a faster idle to prevent engine stalling. This is accomplished by fast idle cam which is connected by a link to the choke shaft. During cold engine starting, the idle screw will rest on the highest step of the fast idle cam. When started and the choke valve is partially open the idle screw drops to the second highest step and so on, until the engine is fully warm and the choke valve is wide open. At this point the idle screw will be on the lowest step of the fast idle cam where normal curb idle is obtained.

If the engine becomes flooded during the starting period, the choke valve can be partially opened manually to allow increased air flow to the carburetor. This is accomplished by depressing the accelerator pedal to the floor. The unloader projection on the throttle lever contacts the edge of the fast idle cam and, in turn, partially opens the choke valve.

## ADJUSTMENTS ON CAR

All Rochester BV adjustments can be performed on the car. With the exception of the idle speed and mixture adjustment, all adjustments are included in the "Overhaul and Adjustments" procedure. Following are the idle speed and mixture adjustments.

### *IDLE SPEED AND MIXTURE ADJUSTMENT*

With the engine at operating temperature, adjust idle speed to the following specifications:

Synchromesh . . . . . . . . . . . . . 580-600 rpm

Automatic (In Drive) . . . . . . . . . 480-500 rpm

Air Conditioned:
(Automatic Drive Position -
Air Conditioning off
Hot Idle Compensator Closed). . 480-500 rpm

(S/M Neutral -
Air Conditioning off
Hot Idle Compensator Closed). . 580-600 rpm

1. As a preliminary setting, turn idle mixture screw out 1-1/2 turns from lightly seated position and speed screw in 1/2 to one turn from throttle closed position.

2. Set hand brake securely, place transmission in neutral and connect tachometer to engine.

3. Start engine and warm up thoroughly. Be sure choke is fully open and carburetor is completely off fast idle.

4. Place automatic in "drive" and adjust idle speed screw to obtain specified idle speed.

5. Turn mixture screw to best quality (highest rpm) idle.

6. Reset idle speed screw to specified idle speed if mixture adjustment changed setting.

7. Recheck mixture adjustment to insure smoothest possible idle.

*NOTE: Always recheck idle mixture setting after making idle rpm adjustment with idle speed screw.*

8. Adjust idle speed-up device on 6 cyl. A/C cars as follows:

Set hot idle speed and mixture as above and on automatic transmissions leave transmission in drive. Turn air conditioning on for maximum cooling and adjust diaphragm plunger screw to obtain the following engine speeds.

| | |
|---|---|
| A. Automatic transmission | 480-500 |
| B. Synchromesh transmission | 580-600 |

*CAUTION: The idle speed-up diaphragm plunger must be restrained from turning while adjusting plunger screw to prevent injury to diaphragm.*

## OVERHAUL AND ADJUSTMENT

### DISASSEMBLY OF CHOKE

1. Disconnect choke vacuum break hose at diaphragm unit and from pipe in throttle body.

2. Remove choke shaft lever screw (diaphragm side), remove two diaphragm bracket screws and remove vacuum break diaphragm assembly.

3. Remove fast idle cam attaching screw. Then the fast idle cam and choke rod can be removed from upper choke lever by carefully rotating assembly upward and sliding end of rod out of upper choke lever. The choke rod can now be removed from the fast idle cam by rotating cam over end of rod.

4. To remove choke valve, remove stake on the end of choke valve screws. Then remove the two choke valve attaching screws from the choke shaft and pull upward on choke valve to remove from shaft. Choke shaft and lever assembly can now be removed from air horn.

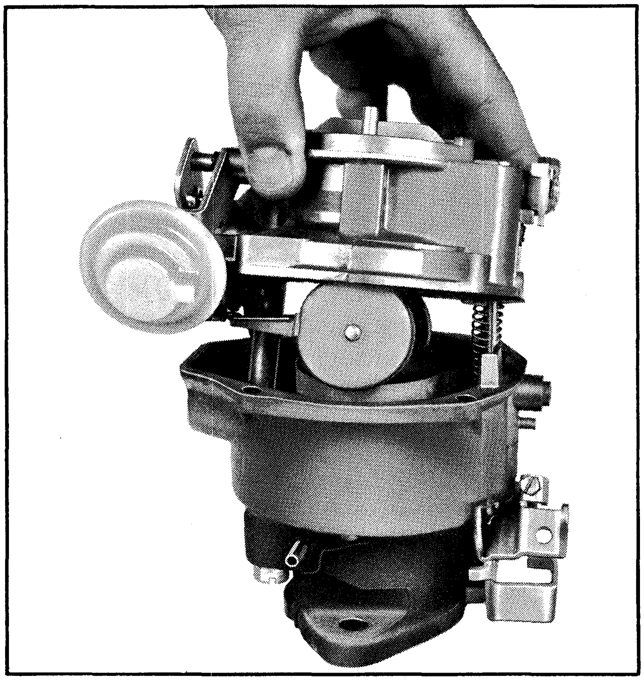


Fig. 6B-17 Removing Air Horn

Note position of choke trip lever in relation to upper choke lever tang for ease in reassembly.

### DISASSEMBLY OF AIR HORN

1. Remove fuel filter inlet nut and gasket with 1" wrench. Then remove filter, filter spring and gasket between filter element and back side of inlet nut (Fig. 6B-16).

*NOTE: Large open end of filter element always faces the fuel inlet nut.*

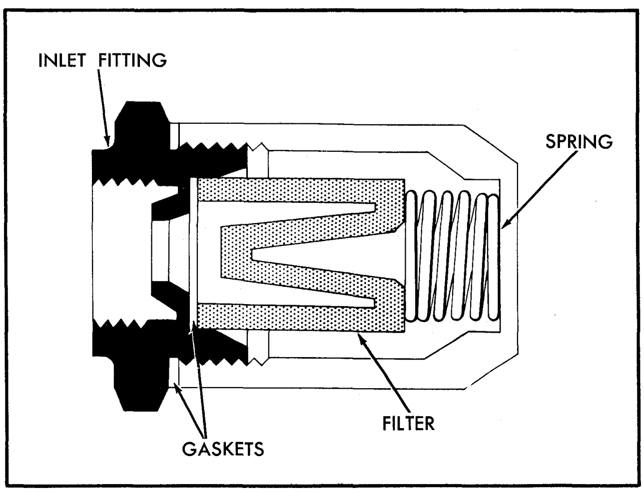



Fig. 6B-16 Fuel Inlet Components

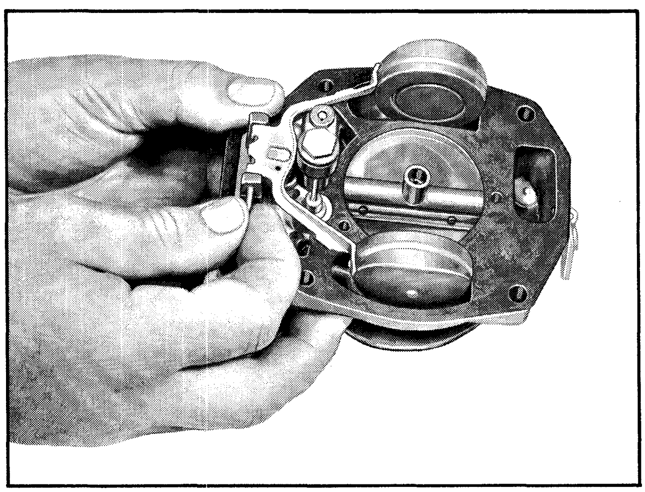


Fig. 6B-18 Removing Float Hinge Pin

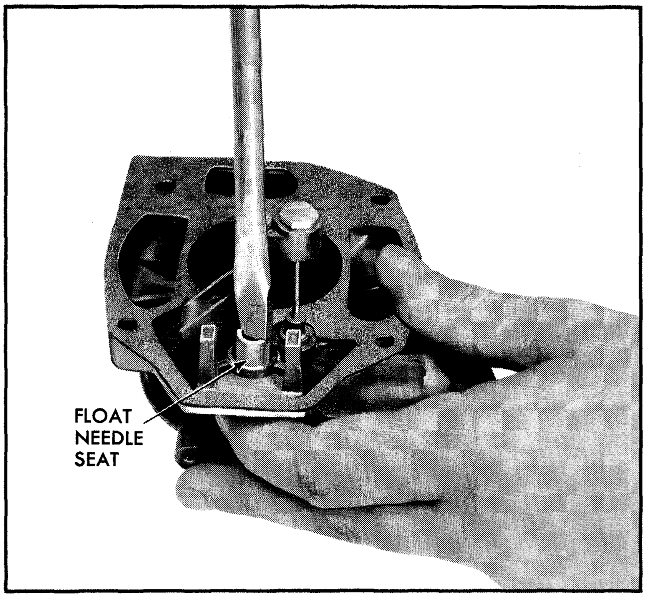



Fig. 6B-19 Removing Float Needle Seat

2. Remove four air horn attaching screws. Lift air horn straight up from bowl so as not to damage float (Fig. 6B-17). Place air horn, inverted, on a flat surface.

3. Remove float hinge pin and lift float assembly from air horn (Fig. 6B-18). Float needle may now be removed.

4. Remove float needle seat and gasket with 1/2" bit screwdriver or special needle seat removing tool (Fig. 6B-19).

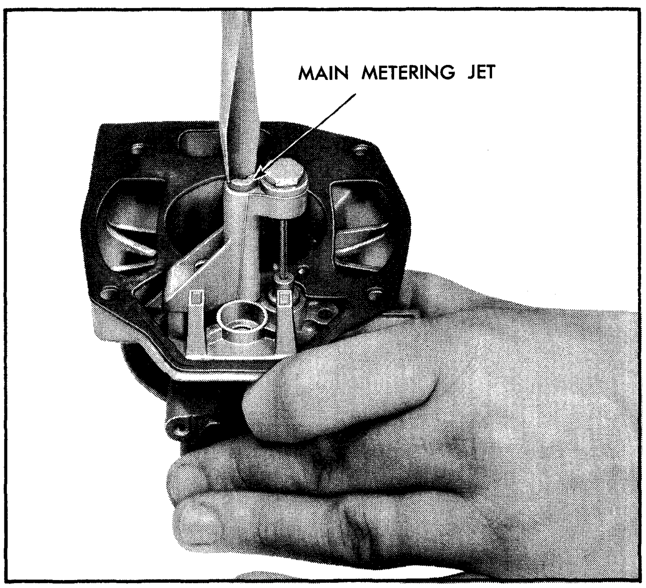



Fig. 6B-20 Removing Main Metering Jet

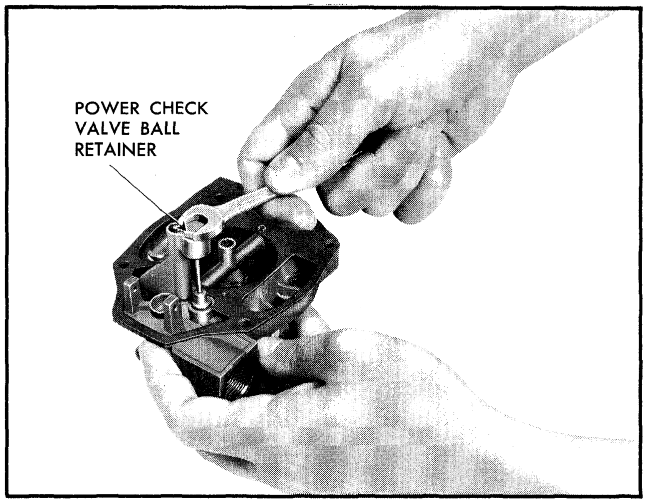



Fig. 6B-21 Removing Power Check Valve Ball Retainer

5. Remove main metering jet from bottom of main well support (Fig. 6B-20).

6. Remove hex head power valve check ball retainer from bottom of support, then remove power valve spring and ball (Fig. 6B-21).

*NOTE: Use care when removing power valve so as not to lose small spring and ball.*

7. Remove screw at base of main well support, then remove the main well support from air horn.

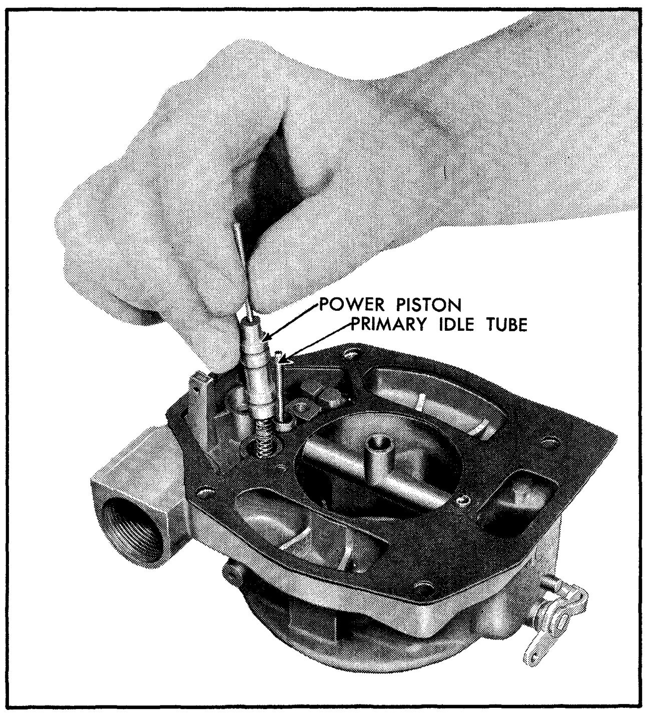



Fig. 6B-22 Removing Power Piston

8. Remove power piston and power piston spring from air horn (Fig. 6B-22).

*NOTE: Do not remove idle pick up tube from air horn as it is pressed in place. The anti-bubble screen located inside the main well should not be removed. Clean and blow out dry with compressed air only.*

9. Remove air horn gasket.

### DISASSEMBLY OF FLOAT BOWL

1. Using a pair of long nosed pliers, remove pump discharge guide (Fig. 6B-23). Pump discharge spring and ball may now be removed by inverting bowl and shaking into palm of hand.

2. Remove two hair pin clips from pump link and then remove pump link from throttle lever and pump plunger rod.

3. Remove the pump plunger from the float bowl by pulling straight upward (Fig. 6B-24).

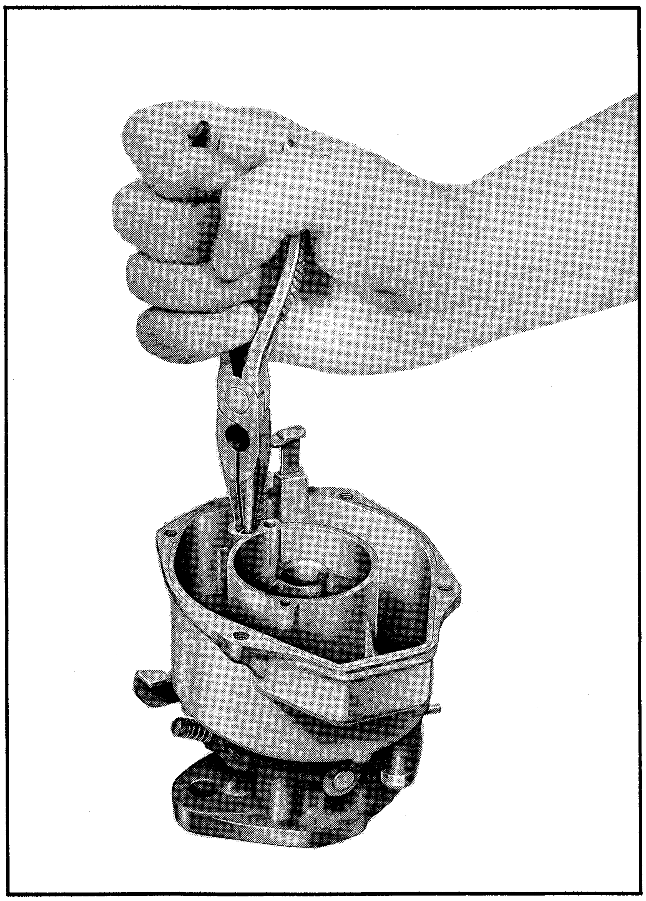


Fig. 6B-23 Removing Pump Discharge Guide

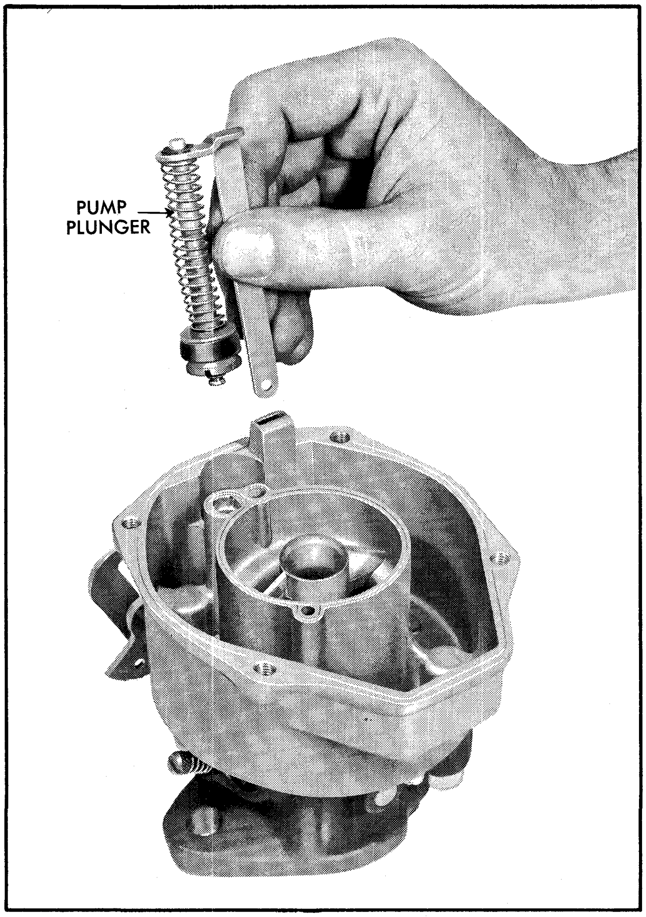



Fig. 6B-24 Removing Pump Plunger

4. Remove pump return spring from bottom of pump well (Fig. 6B-25).

*NOTE: Do not remove vacuum break suction tube from throttle body.*

5. Place carburetor bowl with suction tube projected over edge of flat surface and remove two throttle body attaching screws. Throttle body and gasket may now be removed.

### DISASSEMBLY OF THROTTLE BODY

1. Remove idle mixture adjusting needle and spring.

2. Remove idle stop screw from throttle lever if necessary to replace.

*NOTE: Due to close tolerance fit of the throttle valve in the bore of the throttle body, do not remove the throttle valve or shaft from the throttle body.*

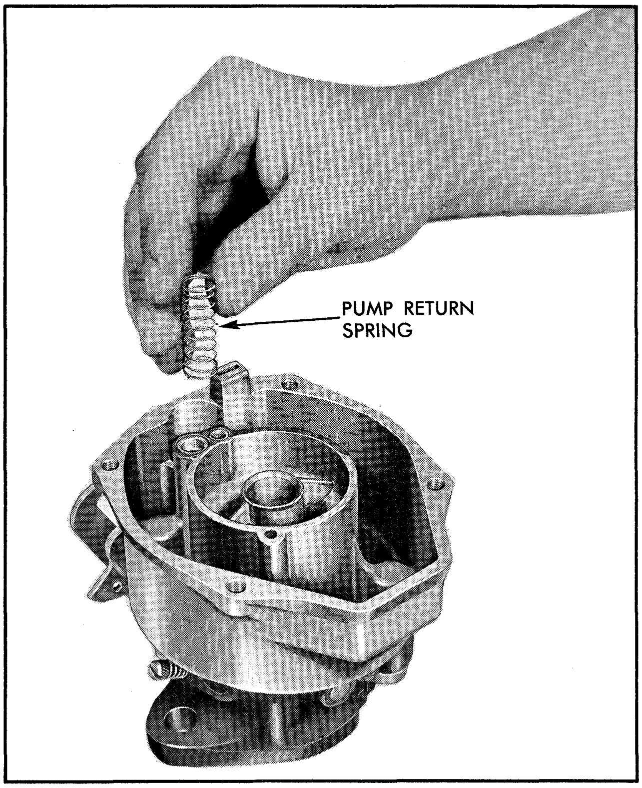



Fig. 6B-25 Removing Pump Return Spring

### CLEANING AND INSPECTION

1. Thoroughly clean carburetor castings and metal parts in carburetor cleaning solvent.

*CAUTION: Pump plunger and any synthetic or plastic parts should not be immersed in commercial carburetor cleaner. Clean in clean solvasol or equivalent. Plastic vacuum break diaphragm unit should not be immersed in any cleaner.*

2. After cleaning, blow all passages and castings with compressed air and blow out all parts until dry.

*CAUTION: Do not pass drills or wires through calibrated jets or orifices as this may enlarge orifice and seriously affect carburetor calibration.*

3. Check all parts for wear. If wear is noted, defective part must be replaced.

*NOTE: Especially the following:*

a. Check float needle and seat for wear.

b. Check tank on float arm above float needle for wear and floats for dents. Check floats for leaks by shaking.

c. Check throttle and choke shaft bores in throttle body and air horn castings for wear or out of round.

d. Check idle mixture needles for burrs or ridges.

e. If wear is noted on the steps of the fast idle cam, it should be replaced as it may upset engine idle during the engine warm-up period.

f. Inspect pump plunger. Replace plunger if leather or synthetic rubber is scored, hardened or damaged.

g. Check pump plunger vent ball to make sure it is free inside pump plunger head. This may be done by shaking, ball should rattle freely.

h. Inspect for burrs on the power piston or a distorted power piston stem or spring.

4. Always use new gaskets in reassembly.

5. Clean all dirt or lint out of the fuel inlet filter. If filter remains plugged, replace it. Check relief spring for distortion, replace it if necessary.

6. Thoroughly clean anti-bubble screen in main well. If screen remains plugged, replace main well support.

### THROTTLE BODY ASSEMBLY

1. Install idle stop screw in throttle lever, if removed.

2. Screw idle mixture adjusting needle and spring into throttle body until it is finger tight. Back needle out 1-1/2 turns as a temporary idle mixture adjustment.

3. Using a new gasket, attach throttle body to bowl using two screws and lockwashers. Tighten screws evenly and securely.

*NOTE: If needed, a new vacuum seal will be installed after carburetor is completely assembled.*

### FLOAT BOWL ASSEMBLY

1. Install 3/16" steel ball into pump discharge cavity. Carefully insert pump discharge spring and guide on top of ball. Tap the discharge guide lightly to seat flush with the float bowl casting.

*NOTE: The pump discharge guide is installed correctly when it is at right angles with the pump discharge jet.*

2. Place pump return spring in pump well and bottom spring in well by forcing downward with index finger.

3. Install pump plunger assembly in bowl, making sure not to curl rubber during installation.

4. Attach pump link to pump plunger rod and throttle lever using two hair pin clips.

*NOTE: Dog leg in pump link will face away from throttle shaft when installed correctly. Ends of link will protrude outward away from throttle body.*

### AIR HORN ASSEMBLY

1. Install float needle seat and new gasket using special tool or screwdriver with 1/2" bit.

2. Place new air horn gasket on top air horn, check to be sure that all air horn and gasket holes are in line.

3. Install power piston spring and power piston in vacuum cavity.

*NOTE: Piston should ride free in cavity.*

4. Install power valve ball (small steel ball), power valve spring, and retainer in main well support. Tighten retainer securely.

5. Attach main well support to air horn assembly and tighten attaching screw securely.

*NOTE: Check for free motion of power piston.*

6. Install main metering jet in main well support.

7. Place float needle in float needle seat.

8. Place float carefully in position with drop tang pointing downward towards air horn and install float hinge pin.

### FLOAT LEVEL ADJUSTMENT (Fig. 6B-26)

With the air horn inverted and gasket in place, measure the distance from the air horn gasket to the bottom of each float, as shown. Bend the adjustment

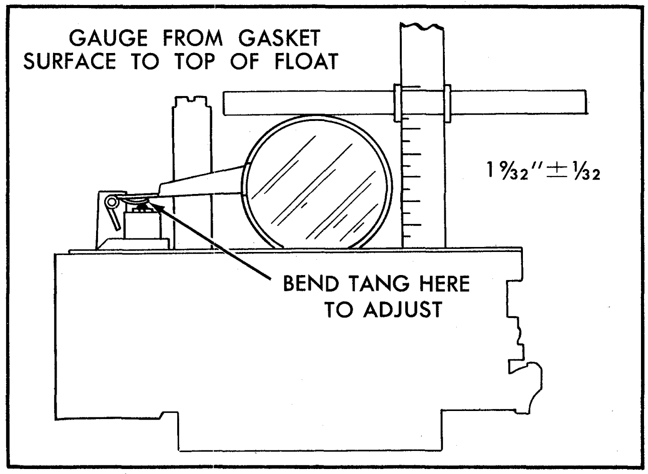



Fig. 6B-26 Float Level Adjustment

tang on float arm which contacts float needle, as necessary, to obtain the specified dimension of 1-9/32" ± 1/32".

Align floats by making sure they are parallel and centered in the air horn gasket cut out. Recheck float level adjustment if float alignment is necessary.

### FLOAT DROP ADJUSTMENT (Fig. 6B-27)

Bend the float tang at the rear of the float arm, next to the needle seat, as necessary to obtain a distance of 1-3/4" from the gasket surface to the bottom of the float with the air horn held in the upright position and the float hanging free. Measure with a scale.

9. Install air horn to bowl assembly being careful to lower the air horn straight down so that the floats will not be bent during installation.

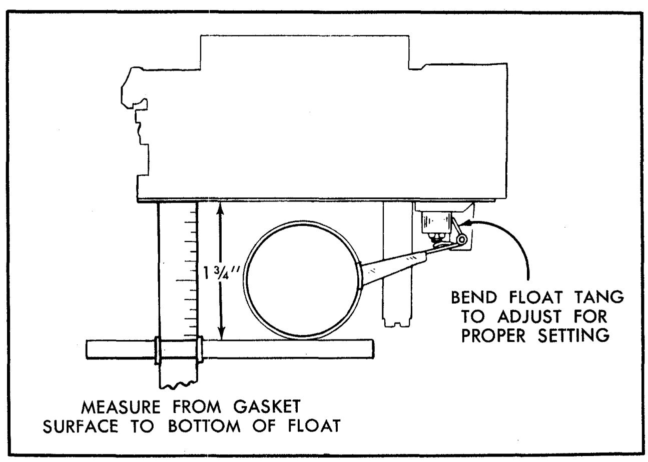



Fig. 6B-27 Float Drop Adjustment

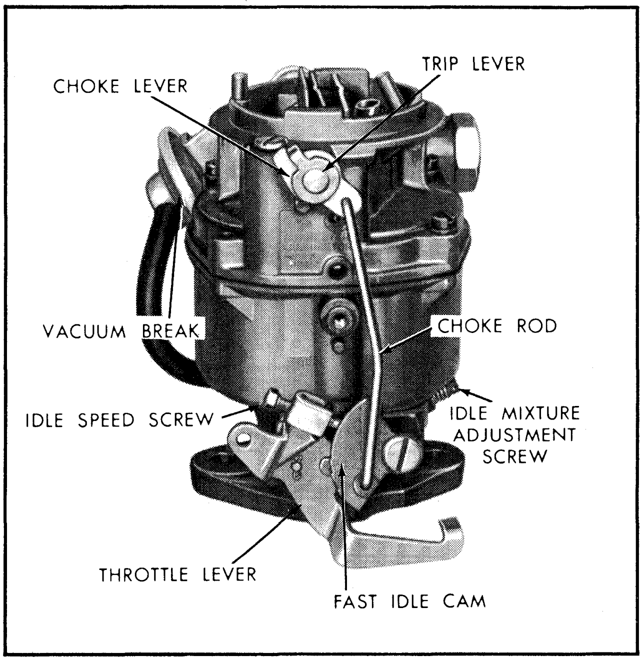



Fig. 6B-28 Trip Lever and Choke Rod Lever

10. Install four air horn to float bowl attaching screws and tighten evenly and securely.

11. Install filter gasket inside fuel inlet nut, filter relief spring, filter element retaining in place with the fuel inlet nut and gasket.

### CHOKE ASSEMBLY

1. Install upper choke rod lever on choke shaft. Tang on the choke lever should point towards air horn casting.

2. Assemble choke shaft into air horn from the throttle lever side. Tang on the trip lever should be above the tang on the choke lever. See Fig. 6B-28.

3. Install choke valve into the slot in the choke shaft. RP trade mark should face upward. Install two choke valve attaching screws.

4. To insure proper end clearance between the choke trip lever and choke rod lever, move the choke shaft horizontally to obtain .020 clearance between the two levers (Fig. 6B-29). Then tighten the two choke valve attaching screws securely and stake in place.

5. Install vacuum diaphragm unit and bracket to side of air horn, retaining with two attaching screws. Tighten securely.

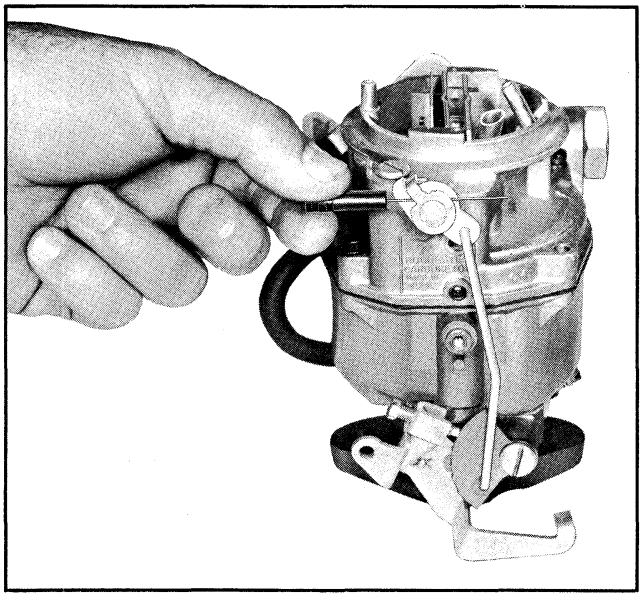


Fig. 6B-29 Trip Lever and Choke Rod Lever Clearance

6. Install choke shaft lever to end of choke shaft (diaphragm side) aligning flats on lever with flats on choke shaft. Large side of lever will hang downward and part no. identification faces outward (Fig. 6B-30). Install retaining screw in end of choke shaft and tighten securely.

7. Install connecting rod to vacuum break diaphragm plunger by rotating end of rod so squirt on

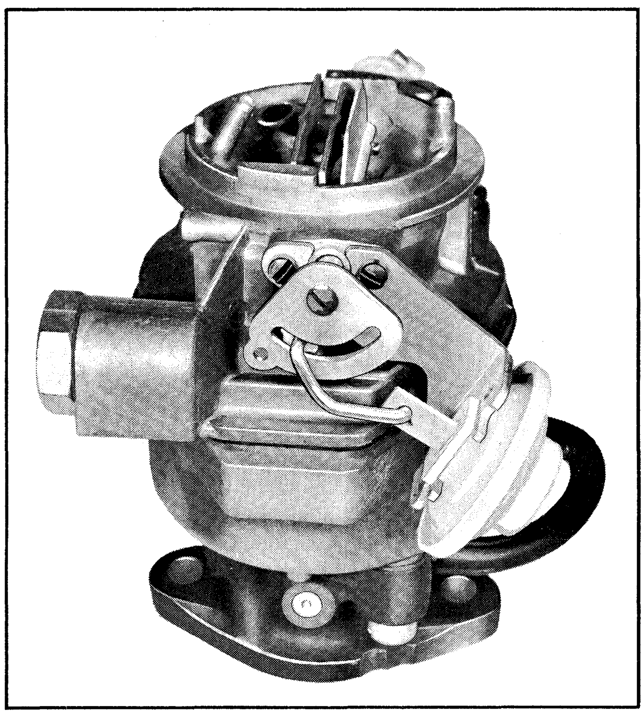


Fig. 6B-30 Choke Shaft Lever Installed

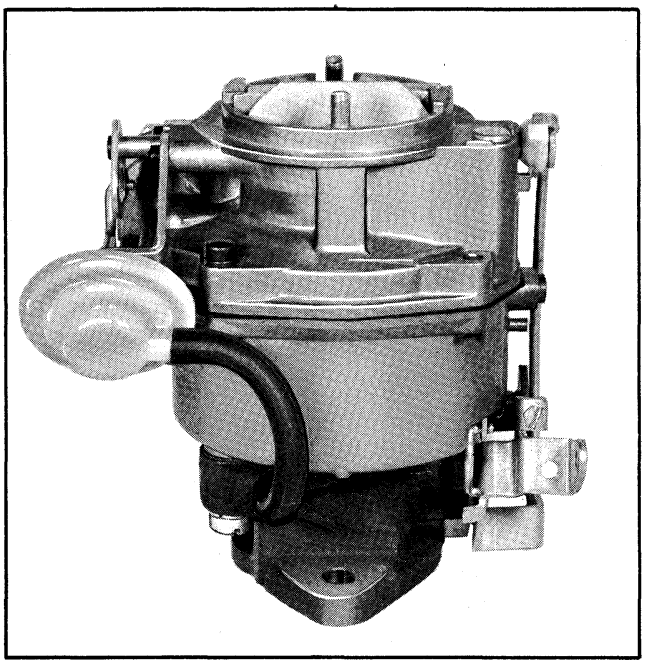


Fig. 6B-31 Vacuum Break Diaphragm Installed

rod enters notch in plunger, ends of rod face inward (Fig. 6B-31). Install other end of rod into slot in choke lever. Install horseshoe clip in groove in rod end and pinch together.

8. Install the choke rod to the fast idle cam as shown, then carefully insert the upper end of the choke rod into the upper choke lever (Fig. 6B-32). The dog leg of rod must face towards the idle mixture adjusting needle.

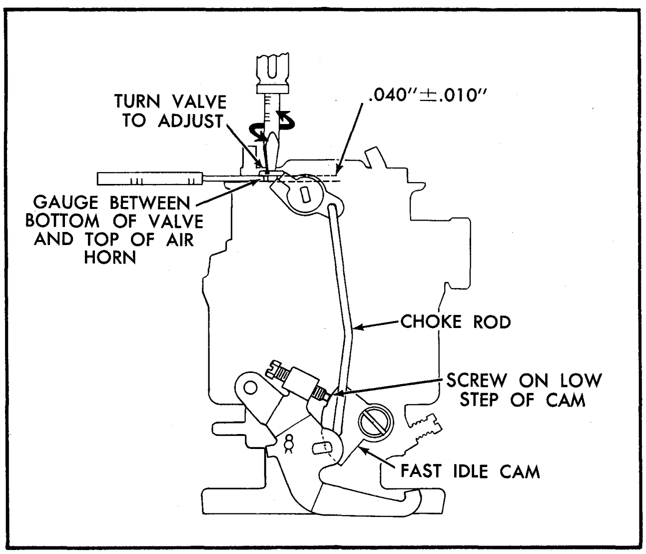



Fig. 6B-32 Idle Vent Adjustment

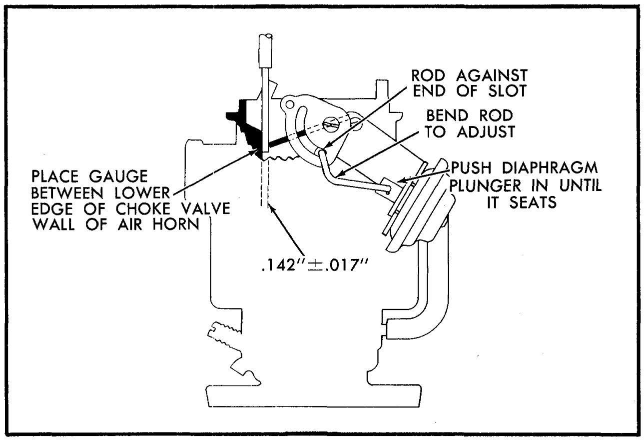



Fig. 6B-33 Vacuum Break Adjustment

9. Attach the fast idle cam to the throttle body assembly with the fast idle cam screw and tighten securely. The steps on the fast idle cam should face towards the idle speed screw (Fig. 6B-32).

### *IDLE VENT ADJUSTMENT (Fig. 6B-32)*

With idle RPM set to specification, and screw on low step of cam, the idle vent valve should be open .040" ± .010" as specified. Adjust by turning valve on top of air horn, as needed.

### *VACUUM BREAK ADJUSTMENT (Fig. 6B-33)*

To insure correct initial choke valve opening, just after engine starting, adjust vacuum break as follows.

Push the vacuum break diaphragm plunger in until seated, make sure the choke valve is held toward the

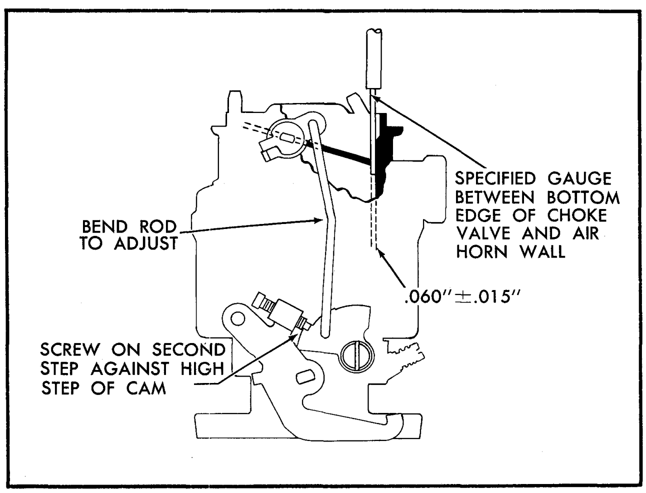



Fig. 6B-34 Choke Rod Adjustment

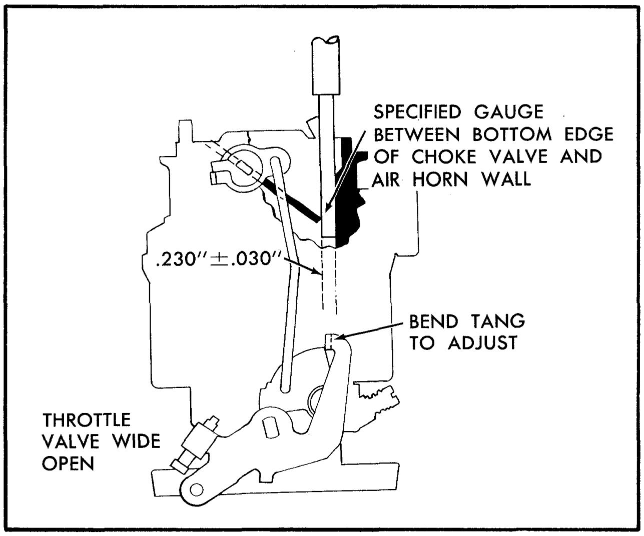



Fig. 6B-35 Unloader Adjustment

closed position so that the connecting rod is at end of the slot. In this position, adjust rod so that .142" ± .017" gauge will fit between lower edge of choke valve and inside of air horn casting.

To adjust, bend the connecting rod at the point shown.

### *CHOKE ROD ADJUSTMENT (Fig. 6B-34)*

With the idle screw resting on the second step of the fast idle cam and against the shoulder of the high step, bend the choke rod as shown to obtain sufficient clearance to allow the insertion of a .060" ± .015" gauge between the lower edge of the choke valve and the dividing wall of the air horn.

### *UNLOADER ADJUSTMENT (Fig. 6B-35)*

Bend the unloader tang on the throttle lever as necessary to allow the insertion of a .230" ± .030" gauge between the lower edge of the choke valve and the dividing wall of the air horn, with the throttle valves held wide open.

*CAUTION: Make sure unloader arm does not interfere with fast idle cam screw after this adjustment.*

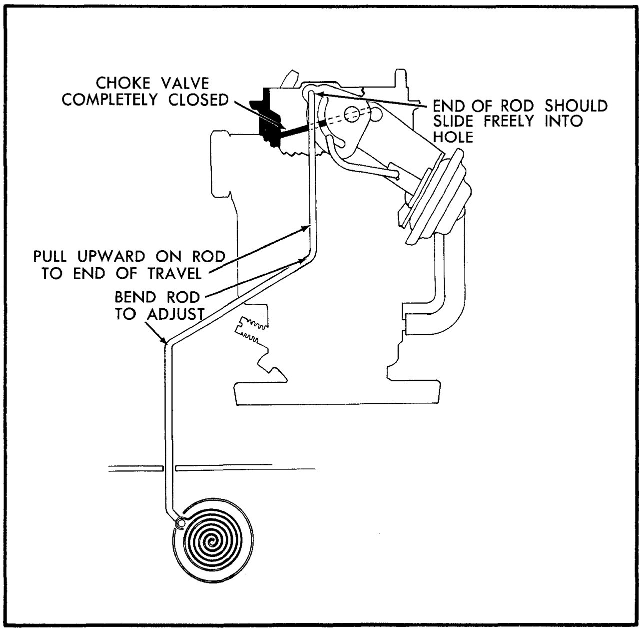



Fig. 6B-36 Automatic Choke Adjustment

### *AUTOMATIC CHOKE ADJUSTMENT (Fig. 6B-36)*

Disconnect upper end of choke thermostatic coil rod from choke lever. Hold the choke valve completely closed and pull up on thermostatic coil rod to the limit of its travel. The lower edge of the rod should be even with the top edge of the hole in choke shaft lever for maximum rod length while the rod should just line up with the hole for minimum rod length.

To adjust, bend rod as shown.

# ROCHESTER 2GC CARBURETOR

## V-8 ENGINE
## (1 11/16" Throttle Bore)

| Carburetor Model Number | Used On |
|---|---|
| 7024062 | V-8 Automatic |
| 7023071 | V-8 Synchromesh |

The Rochester 2GC carburetor used on Tempest V-8 engine incorporates 1-11/16" throttle bores and has the choke housing located on the throttle flange. This model is used as standard equipment on all automatic and synchromesh transmission Tempest V-8s. Rochester 2GC carburetor number 7023071 is used with the synchromesh transmission and number 7024062 is used with the automatic transmission.

## GENERAL DESCRIPTION

The cluster casting is the heart of the carburetor; it embodies the small or secondary venturi, the high speed passages, the main well tubes and nozzles, the idle tubes, and the calibrated air bleeds for both the low and high speed metering system, as well as the accelerating pump jets.

When the cluster is removed, all of these vital parts can be readily seen, cleaned and examined because the main well tubes and idle tubes are permanently installed in the custer body by means of a precision press fit.

The cluster fits on a platform provided in the body casting of the carburetor so that the main well and idle tubes are suspended in the fuel.

A gasket is used between the cluster casting and the body platform.

This method of design and assembly serves to insulate the main well tubes and idle tubes from engine heat thus preventing heat expansion and percolation spill-over during hot idle periods of operation and during the time the hot engine is not operating.

An external idle vent valve is located on the bowl cover which vents any fuel vapors which may form in the fuel bowl during periods of "hot" idle to the atmosphere. The fuel bowl is also internally vented to give a completely balanced carburetor.

The model 2GC carburetor is of side bowl construction. It is designed, however, with fuel supply jets and passages submerged below the liquid level to provide efficient engine operation under all driving conditions.

A carburetor choke housing is located on the throttle body assembly and is connected to the choke valve through an intermediate choke rod.

A center stud mounting provides for secure attachment of the carburetor air cleaner assembly.

Six "systems" are utilized in the Rochester 2GC carburetor. They are: Float System, Idle System, Part Throttle System, Power System, Pump System, and Choke System.

These systems are described and illustrated schematically in the following text.

### *FLOAT SYSTEM (Fig. 6B-37)*

The float system controls the level of fuel in the carburetor bowl.

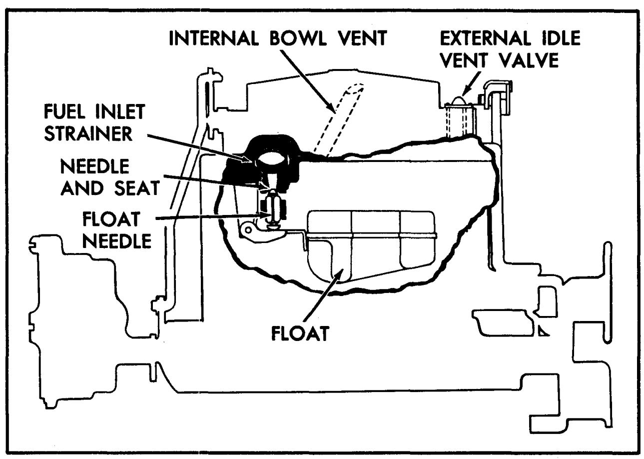



Fig. 6B-37 Float System

Entering fuel first travels through the inlet strainer to remove particles which might block jets or passages. Then the fuel passes through the needle and seat into the carburetor bowl; flow continues until the rising liquid level raises the float to a position where the valve is closed. Thus the fuel level can be regulated by setting the float to close the valve when the proper level is reached.

A tang located at the rear of the float hanger prevents the float from traveling too far downward.

The carburetor is internally vented. The vent transmits the air pressure from beneath the air cleaner to the fuel in the float bowl. The amount of fuel metered by the carburetor is dependent upon the pressure in the float bowl causing fuel to flow. By locating the vents below the air cleaner, or internally, the carburetor automatically compensates for air cleaner restriction, since the same pressure causing air to flow will also be causing fuel to flow.

An external idle vent, located in the top of the float bowl, vents the bowl to atmosphere during idle operation. In this way any fuel vapors which may form in the bowl during hot idle or when parked will be vented to the outside. The idle vent automatically closes after the throttle valve has moved from the idle position into the part throttle range, returning the carburetor to internal balance.

***IDLE SYSTEM (Fig. 6B-38)***

The idle system consists of the idle tubes, idle passages, idle air bleeds, idle mixture adjustment needles, idle discharge slot and an idle air adjustment screw.

In the curb idle speed position, the throttle valves are held open by the speed adjusting screw.

In order to obtain sufficient idle air for stable idle speed adjustment, a fixed air bleed is necessary; this is accomplished by a drilled hole in each throttle valve. The fixed idle air bleeds maintain a constant idle air flow for part of the idle air requirements, while the idle speed adjustment screw regulates the remainder of the idle air. Thus, the engine idle speed can be adjusted by the idle speed adjustment screw.

The idle mixture needle hole is in the high vacuum area below the throttle valve while the fuel bowl is vented to atmospheric pressure. Vacuum can be called a lack of pressure, so a high vacuum area

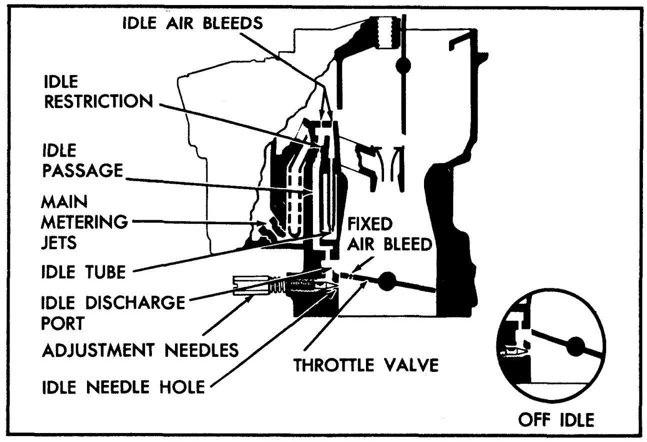



Fig. 6B-38 Idle System

can be spoken of as an area of low pressure. Thus it can be said that there is considerable pressure difference between the normal atmospheric pressure on the fuel in the bowl and the low pressure (or high vacuum) at the idle mixture needle hole.

The fuel and fuel/air mixture will be forced by atmospheric pressure to occupy any low pressure area. It will flow from the fuel bowl to the manifold in the following manner:

The atmospheric pressure acting on the fuel in the bowl forces fuel through the main metering jets into the main well. It is metered by the idle fuel metering orifice at the lower tip of the idle tube and travels up the idle tube. When the fuel reaches the top of the idle tube, it mixes with air entering through the primary idle air bleed. The mixture moves through the horizontal idle passage where more air is added at a second idle air bleed and then down through a restriction in the vertical passage which serves to further break up the fuel. More air is picked up at a third idle air bleed just below the idle restriction.

The fuel/air mixture next moves down the vertical idle passage to the idle discharge slot located just above the throttle valve. Through this slot further air is added to the mixture, which then passes through the idle mixture needle hole.

In addition to this mixture of fuel and air, there is air entering the carburetor bore through the fixed idle air bleeds. For smooth operation, the air from the idle needle hole must combine to form the correct final mixture for curb idle engine speed.

The position of the idle adjustment needle governs the amount of fuel/air mixture admitted to the carburetor bore.

Except for this variable at the idle adjustment needle, the idle system is specifically calibrated for low engine speeds.

A hot idle compensator is incorporated in all carburetors on cars equipped with automatic transmission. The function of the idle compensator is to prevent rough idle and stalling during prolonged hot idle conditions.

It consists of a bi-metal strip, a valve and mounting bracket. The idle compensator is mounted between the venturi on the large bore carburetors and on the back of the carburetor on the bowl casting on small bore carburetors. Below the compensator is a passage leading to manifold vacuum below the throttle blades.

As engine and underhood temperatures rise to a predetermined value, the bi-metal strip lifts the valve off its seat. This allows fresh air to enter the manifold below the throttle valves and off-set rich mixtures due to fuel vapors that are causing the rough idle and stalling.

When underhood temperatures return to normal, the bi-metal strip will lower and the compensator valve will close and normal idle operation will resume.

*NOTE: No adjustments are necessary on the idle compensator. The compensator valve must be closed while adjusting engine idle.*

There is no distributor vacuum advance at idle with this carburetor installation on the Tempest V-8 with synchromesh transmission.

### PART THROTTLE SYSTEM (Fig. 6B-39)

As the throttle valve is opened, there is a change in pressure differential points.

Opening of the valve progressively exposes the idle discharge slot to manifold vacuum and the air stream with the result that they deliver additional fuel/air mixture for fast idle engine requirements.

Further opening of the throttle valve increases the speed of the air stream passing through the venturi, thus lowering the pressure (or raising the vacuum) in the small venturi area of the carburetor bore. At the same time, the edge of the throttle valve is moved away from the wall of the bore, progressively reducing the vacuum and thus the mixture flow at the idle discharge slot.

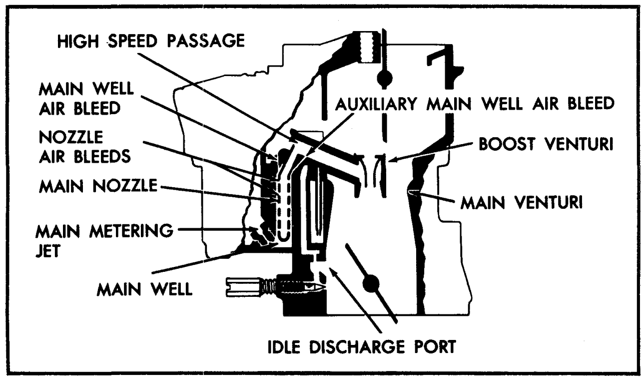



Fig. 6B-39 Part Throttle System

Since the low pressure point is now in the small venturi area, fuel and fuel/air mixture will be forced from the fuel bowl through the main metering system to the venturi as follows:

The fuel passes through the main metering jet into the main well, where it rises in the main well tube. Air entering through the main well air bleeds in the cluster is mixed with the fuel through the main well tube vents. The mixture continues up the main well tube through the nozzle, where more air is added. The mixture flows through the high speed passage to the small venturi, mixes with additional air and moves on to the bore of the carburetor, through the intake manifold, and into the cylinder as a final mixture for part throttle operation.

A second high speed bleed is incorporated in the cluster of large bore 2GC carburetors only. This bleed is drilled from the main well to the high speed passage and serves two purposes. It transmits low pressure from the secondary venturi and high speed passage to the main well, thereby, helping to raise fuel level. This raising of the level assists the initial feeding of fuel at low speed and also helps control the mixture during high speed operation.

As the throttle opening is increased and more fuel is drawn through the main well tubes the fuel level in the main well drops. More holes in the main well tubes are then exposed to the air in the upper well area and become air bleeds. This maintains the proper fuel/air mixture to the engine throughout the part throttle range.

Permanent jets and air bleeds calibrate the main metering system for efficient part throttle operation.

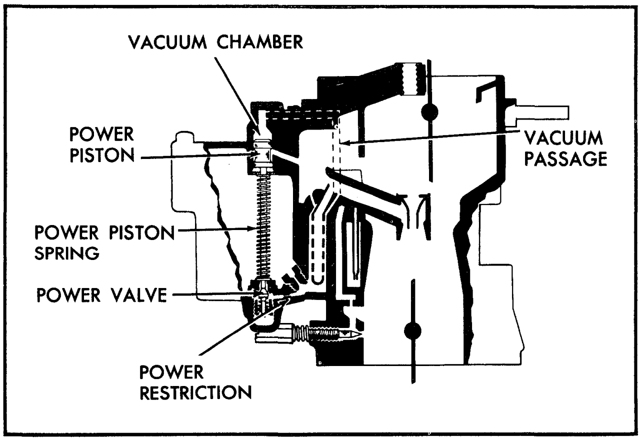



Fig. 6B-40 Power System

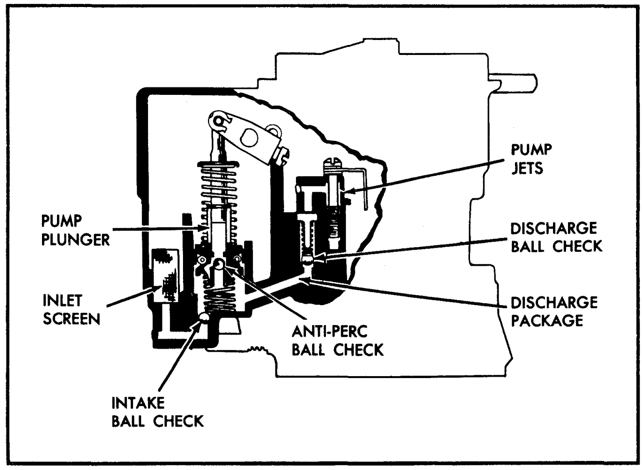



Fig. 6B-41 Pump System

***POWER SYSTEM (Fig. 6B-40)***

As was pointed out under part throttle operation, the fuel level in the main well area drops as the throttle valves are opened. This is due to the fact that more fuel is drawn through the main well tubes, but the supply to the main well is held constant by the opening in the main metering jet. For high speed and/or heavy load conditions an additional source of fuel for the main well area is required. The power system accomplishes this purpose.

A spring loaded power piston, controlled by vacuum, regulates the power valve to supply the additional fuel.

The power piston vacuum channel is open to manifold vacuum in the carburetor bore beneath the throttle valves; thus the vacuum in the channel rises and falls with manifold vacuum.

During idle and part throttle operation, manifold vacuum in the channel is high. Therefore, air pressure in the passage beneath the power piston holds the piston in the fully raised position against the tension of the spring. As the load or speed is increased the throttle valves open wider and manifold vacuum drops. The calibrated spring forces the power piston down against the power valve to open it and allow fuel to flow through the power restrictions into the main wells. The amount of fuel is controlled by the main metering jet and the power restriction.

A two-step valve allows a gradual increase in fuel flow as the power valve is opened; at full throttle position, the power valve is fully opened to permit maximum calibrated fuel flow from the power system.

When the load is decreased the throttle valves close and manifold vacuum is increased. Therefore, air pressure below the power piston gradually overcomes the piston spring tension and forces the piston upward to its original position with the power valve fully closed.

***PUMP SYSTEM (Fig. 6B-41)***

Extra fuel for smooth, quick acceleration is supplied by a double spring pump plunger. A rapid opening of the throttle valves, as is the case when accelerating from low speeds, causes an immediate increase in air velocity. Since fuel is heavier than air it requires a short period of time for it to "catch" up with the air flow. To avoid a leanness during this momentary lag, the accelerator pump furnishes a quantity of liquid fuel sprayed into the air stream to mix with incoming air and maintain the proper fuel/air mixture.

The pump is operated by the combined action of two springs which are calibrated to move the plunger in such a manner that a sustained charge of fuel is delivered for smooth acceleration.

The pump is attached by linkage to the accelerator so that when the throttle valves are closed the pump plunger moves upward in its cylinder creating a low pressure area (partial vacuum) in the cylinder below the plunger. Atmospheric pressure acting on the fuel in the bowl forces fuel into the cylinder through the intake ball check. The discharge ball is seated at this time to prevent air being forced into the cylinder.

When the plunger is moved downward for acceleration, the force of the stroke seats the intake ball

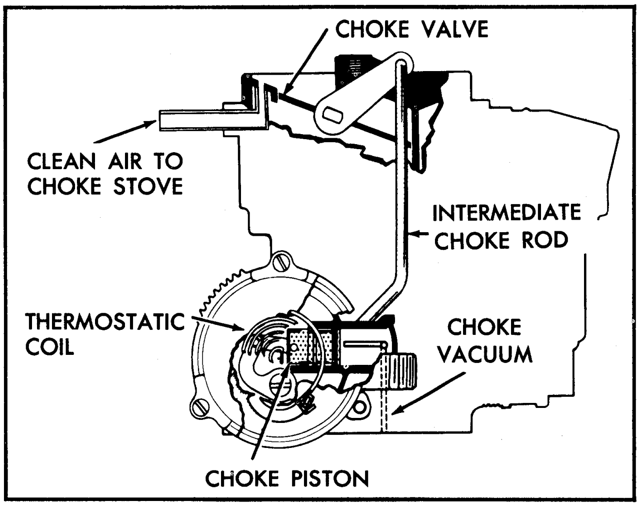



Fig. 6B-42 Choke System

check to prevent flow to the fuel bowl, and the fuel is forced up the pump discharge passage. The pressure of the fuel lifts the pump outlet ball check from its seat and the fuel passes on through the pump jets in the cluster; where it is sprayed into the venturi and delivered to the engine.

At higher speeds pump discharge is no longer necessary to insure smooth acceleration. When the throttle valves are opened, a predetermined amount the pump plunger bottoms in the cylinder eliminating pump discharge.

An "anti-percolator" check valve, contained inside the plunger, provides relief for any vapors which might form during hot idle or when a hot engine is not operating. The ball check is designed so that it can move up and down in its passage. Throughout the above periods it is seated by gravity and vapors in the pump well rise and by-pass the ball check through small holes in the plunger head.

The "anti-perc" ball check also acts as an extra inlet during the upstroke of the pump plunger, but is seated by fuel when the plunger moves downward.

### *CHOKE SYSTEM (Fig. 6B-42)*

The purpose of the choke system is to provide a rich mixture for cold engine operation. It is necessary to have an extra rich mixture because fuel vapor has a tendency to condense on the cold engine parts; thus decreasing the amount of combustible mixture available at the combustion chamber.

The choke system subjects all fuel outlets in the bore of the carburetor to manifold vacuum while restricting the intake of air.

The choke system includes a thermostatic coil, housing, choke piston, choke valve, and fast idle cam and linkage. It is controlled by a combination of manifold vacuum, air velocity against the offset choke valve, and tension of the thermostatic spring.

When the engine is cold, tension of the thermostatic coil holds the choke valve closed. Starting the engine causes air velocity to strike the offset choke valve. This tends to open it along with the action of intake manifold vacuum on the choke piston. After a slight opening of the choke valve, the tension of the thermostatic coil spring balances the force of air on the valve and the pull of vacuum at the piston.

As the engine warms up manifold vacuum exists in the choke housing. Clean hot air from the choke stove is forced into this low pressure area through a passage in the side of the choke housing to heat the thermostatic coil.

The clean air is supplied to the choke stove in the manifold from the air horn, above the choke valve (just below the air cleaner). Here filtered air from the air cleaner is picked up and carried to the stove by a metal pipe.

A secondary baffle plate serves to distribute the heat from its entering point at the side of the coil throughout the choke housing, to prevent a "hot spot" in the coil center, which would cause a rapid opening of the choke valve. The choke baffle is designed in some models with a hole or holes drilled in it. These holes are used to further control heat to the choke coil and, thereby, finely tailors the choke to the particular engine model. The thermostatic coil "relaxes" gradually until the choke is fully open.

If the engine is accelerated during warm-up, the corresponding drop in manifold vacuum on the choke piston allows the thermostatic coil to momentarily close the choke, providing a richer mixture.

During warm-up it is necessary to provide a fast idle to prevent engine stalling. This is accomplished by a fast idle cam connected to the choke shaft. The idle speed screw on the throttle lever contacts the fast idle cam and prevents the throttle valves from returning to the idle position until the choke valve is fully open.

If the engine becomes flooded during the starting period, the choke valve can be partially opened manually to allow increased air flow through the carburetor. This is accomplished by depressing the accelerator pedal to the floor. The unloader projection on the throttle lever contacts the unloader lug on the fast idle cam and in turn partially opens the choke valve.

## ADJUSTMENTS ON CAR

All Rochester 2GC adjustments can be performed on the car. With the exception of the idle speed and mixture adjustment all adjustments are included in the OVERHAUL AND ADJUSTMENTS procedure. Following are the idle speed and mixture adjustments.

Whenever idle speed screw is turned, the throttle should be opened slightly then closed to seat screw properly on cam.

### *IDLE SPEED AND MIXTURE ADJUSTMENT*

With the engine at operating temperature adjust idle speed to the following specifications.

Synchromesh, exc. Air Conditioning . . 580-600 rpm
Automatic, exc. Air Conditioning . . . . 480-500 rpm (in drive range)
Air Conditioning
(Automatic drive range, air conditioning off) . . . . . . . . . . 540-560 rpm
(S/M neutral, air conditioning off) . . . . . . . . . . . . . . . . . . 640-660 rpm

The idle mixture should be adjusted to give a smooth idle at the specified idle speed. Missing is a sign of too lean an idle mixture while "rolling" or "loping" indicates too rich a mixture. Turning the idle mixture screw in, leans out the mixture; one and one-half turns out from the lightly seated position may be used as a preliminary setting of the mixture screws.

*NOTE: All two barrel carburetors used on Tempest V-8 engines with automatic transmission have a hot idle compensator. During idle adjustment make sure the hot idle compensator is closed by depressing the spring loaded button.*

## PERIODIC SERVICE

There are no periodic services required on the Rochester 2GC carburetor; however, choke linkage, choke valve and levers and pump linkage should be kept free of dirt and gum so that they will operate freely. DO NOT OIL LINKAGE.

## OVERHAUL AND ADJUSTMENT

Flooding, stumble on acceleration and other performance complaints are, in many instances, caused by the presence of dirt, water or other foreign matter in the carburetor. To aid in diagnosing the cause of the complaint, the carburetor should be carefully removed from the engine without draining the fuel from the bowl. The contents of the fuel bowl may then be examined for contamination as the carburetor is disassembled.

The following is a step-by-step sequence by which the Rochester 2GC carburetor may be completely disassembled and reassembled. Adjustments may be made and various parts of the carburetor may be serviced without completely disassembling the entire unit.

### *DISASSEMBLY OF BOWL COVER*

1. Remove fuel inlet filter retainer nut and gasket and remove the filter.

2. Disconnect the pump link (Fig. 6B-44) from the pump lever by removing spring clip. Remove lower end of pump rod from throttle lever by removing clip.

3. Detach choke intermediate rod (Fig. 6B-43) at lower end by removing clip, then detach choke intermediate rod from choke shaft by rotating until the tang on rod clears the slot in lever.

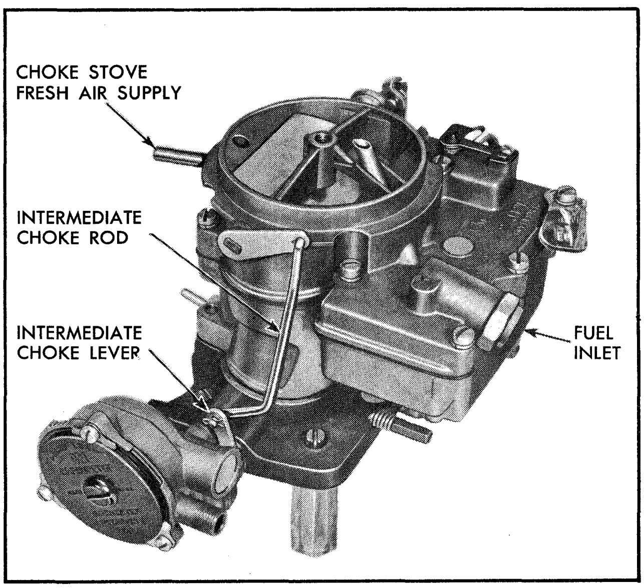



Fig. 6B-43 Rochester 2GC Carburetor

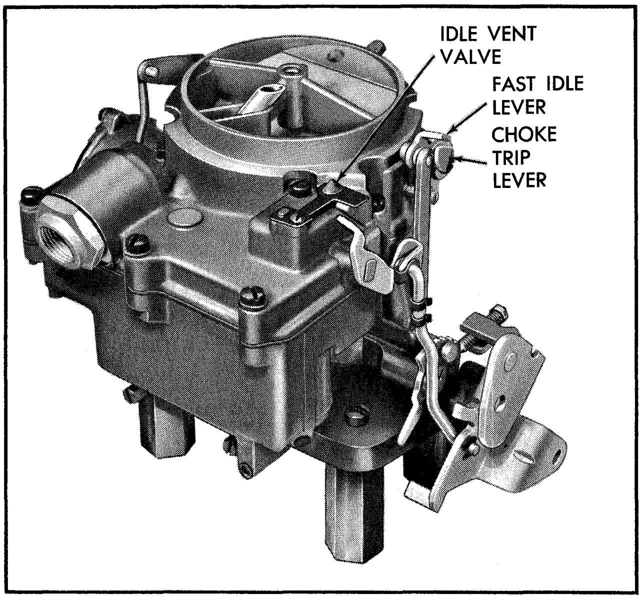



Fig. 6B-44 Rochester 2GC Carburetor

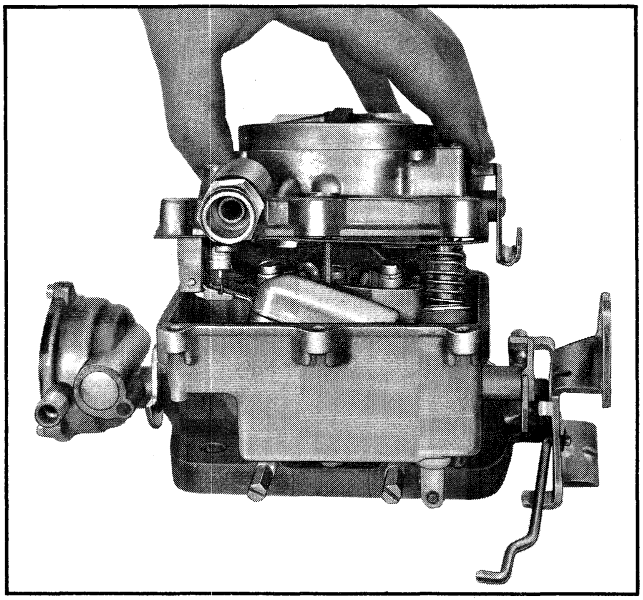


Fig. 6B-46 Removing Bowl Cover Assembly

4. Remove retaining screw at the end of the choke shaft and remove choke trip lever and fast idle link and lever (Fig. 6B-44). Lever can be removed from link by turning until slot in lever will pass over tang on link. The link and fast idle cam are retained by a Truarc washer. Disassembly of these pieces will destroy the Truarc washer.

5. Remove eight cover screws (Fig. 6B-45) and lift cover from bowl (Fig. 6B-46).

6. Place upended cover on flat surface. Remove float hinge pin and lift float assembly from cover (Fig. 6B-46). Float needle may now be removed from seat.

7. Remove float needle seat, screen (Fig. 6B-47) and gasket with wide blade screwdriver.

8. Remove power piston (Fig. 6B-47) by depressing piston stem and allowing it to snap free or by holding stem and tapping lightly on air horn with a non-metallic object. Use care not to bend piston stem.

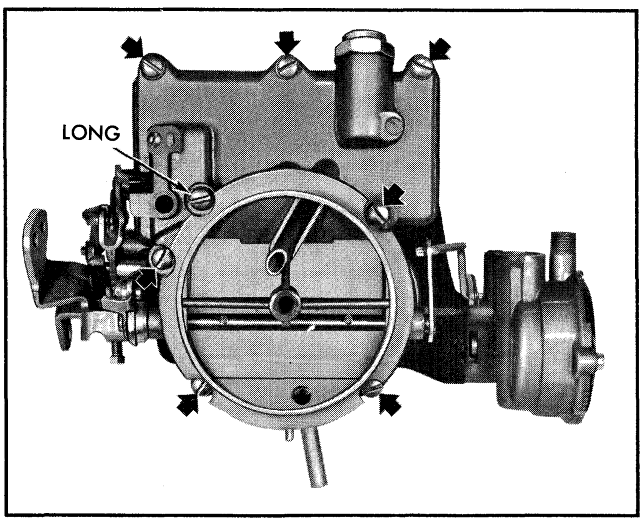



Fig. 6B-45 Location of Cover Attaching Screws

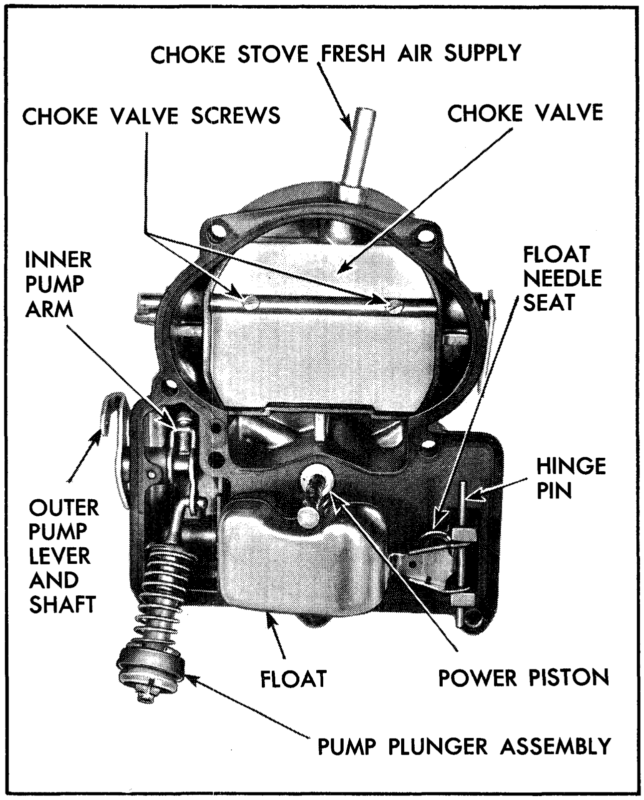



Fig. 6B-47 Bowl Cover Attaching Parts

9. Remove retainer on pump plunger shaft, remove plunger assembly from pump arm (Fig. 6B-47). The pump lever and shaft may be removed by loosening set screw on inner arm and removing outer lever and shaft.

10. The cover gasket may now be removed.

11. Remove idle vent valve.

12. Remove two choke valve attaching screws, then remove choke valve.

13. Remove choke valve shaft from bowl cover.

## DISASSEMBLY OF BOWL

1. Remove pump inlet filter screen and pump plunger return spring, and remove aluminum check ball from bottom pump well (Fig. 6B-48).

2. Remove main metering jets and power valve (Fig. 6B-45).

3. Remove three screws holding cluster to bowl and remove cluster and gasket. Remove deflector also (Synchromesh).

4. Using a pair of long nose pliers, remove the pump discharge spring retainer (Fig. 6B-49). Then the spring and check ball may also be removed.

5. Invert carburetor and remove three large bowl to throttle body attaching screws. Throttle body and gasket may now be removed.

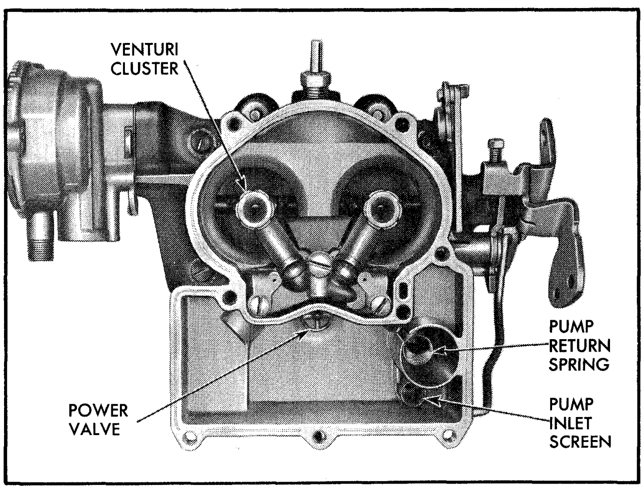



Fig. 6B-48 Carburetor Body Assembly Details

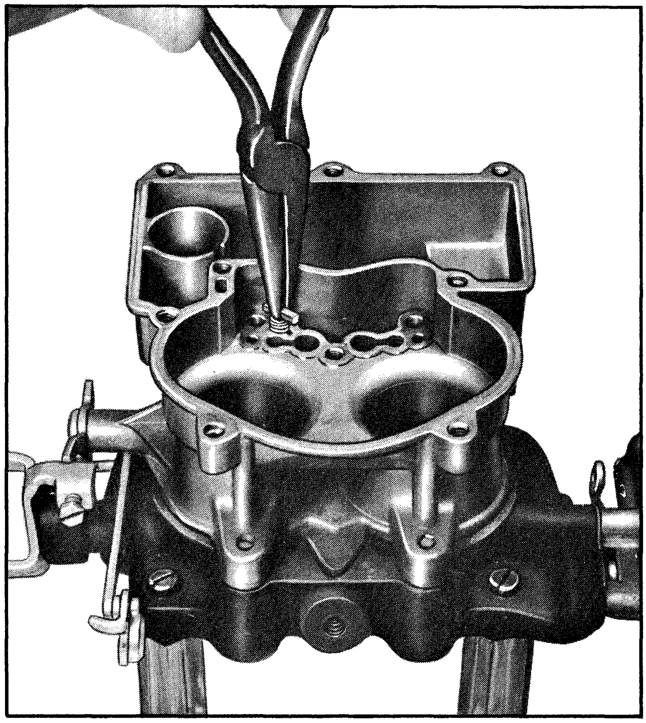


Fig. 6B-49 Removing Pump Discharge Spring Retainer

6. Remove fast idle cam and fast idle link as an assembly. DO NOT disassemble.

7. Remove idle compensator bracket and compensator if present.

## DISASSEMBLY OF THROTTLE BODY

1. Remove idle adjusting needles and springs.

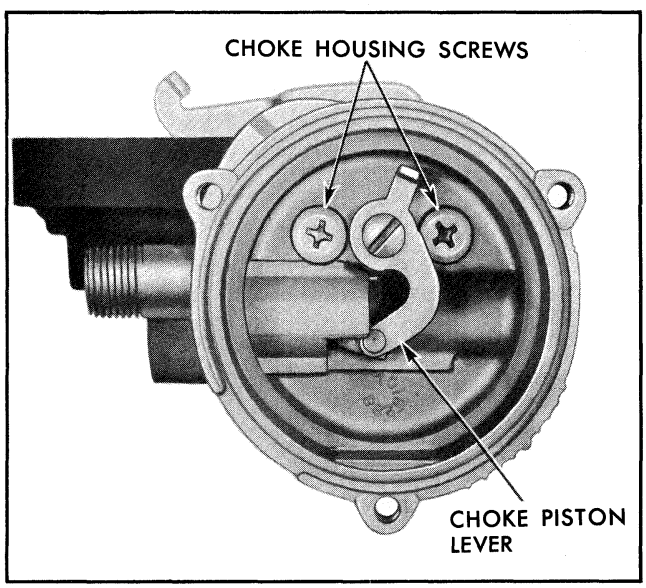



Fig. 6B-50 Choke Housing Screws

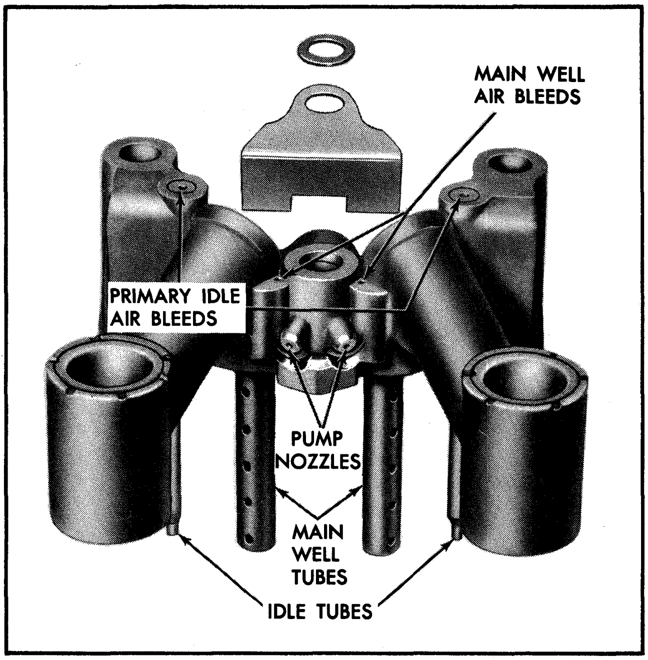



Fig. 6B-51 Passage Identification - Venturi Cluster

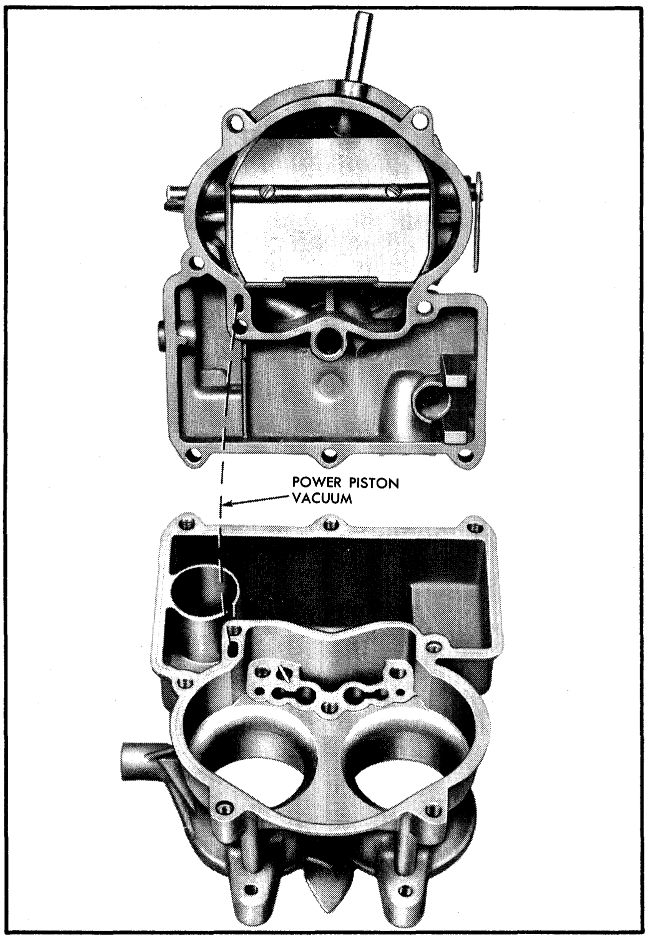



Fig. 6B-52 Passage Identification - Body to Bowl Cover

2. Remove fast idle screw from throttle lever if necessary to replace.

3. Remove the three choke cover attaching screws and retainers, then remove choke cover and coil assembly from choke housing.

4. Remove choke cover gasket and baffle plate.

5. Remove choke piston lever attaching screw (Fig. 6B-50).

6. Remove piston link and lever assembly from carburetor.

*NOTE: Piston can be removed from link by dropping out piston pin.*

7. Remove the two choke housing attaching screws and detach choke housing from throttle body.

8. Remove intermediate choke shaft and lever from choke housing.

### CLEANING AND INSPECTION

Dirt, gum, water or carbon contamination in or on the exterior moving parts of a carburetor are often responsible for unsatisfactory performance. For this reason, efficient carburetion depends upon careful cleaning and inspection while servicing.

1. Thoroughly clean carburetor castings and metal parts in clean cleaning solvent.

*CAUTION: Choke cover and coil, idle compensator, rubber vent valve, gaskets, and pump plunger should not be immersed in solvent. Clean pump plunger in clean gasoline only.*

*To avoid damage to gasket between choke housing and throttle body do not soak the throttle body assembly in cleaner or solvent if choke piston housing has not been removed.*

2. Blow all passages in castings (Figs. 6B-51 through 6B-55) dry with compressed air and blow off all parts until they are dry.

*CAUTION: Do not pass drills or wires through calibrated jets or passages as they may enlarge orifices and seriously affect carburetor calibration.*

3. Check all parts for wear. If wear is noted, defective parts must be replaced. Note expecially the following:

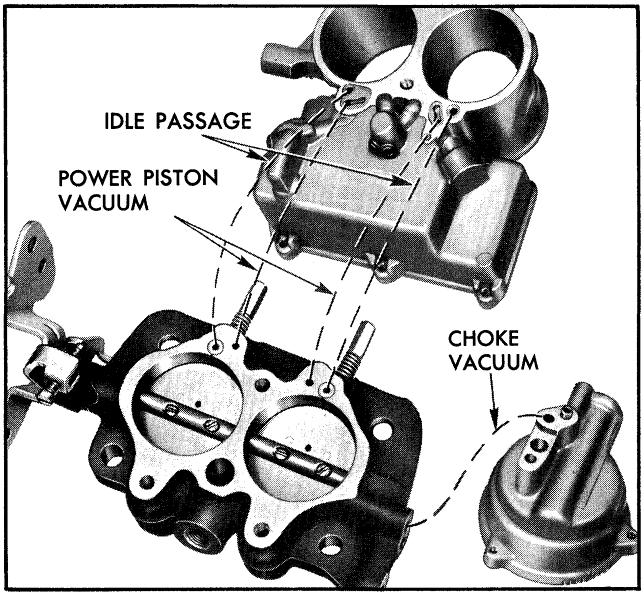



Fig. 6B-53 Passage Identification -

a. Check float needle and seat for wear. If wear is noted the assembly must be replaced.

b. Check float lip for wear and float for dents. Check floats for gasoline leaks by shaking.

c. Check throttle and choke shaft bores in throttle body and cover castings for wear or out of round.

d. Inspect idle adjusting needle for burrs or ridges. Such a condition requires replacement.

e. Inspect fast idle cam—if wear is noted on steps of cam it should be replaced as it may upset engine idle speed during the warm-up period.

f. Inspect pump plunger cup. Replace plunger if cup is damaged.

g. Inspect power piston and spring for burrs or distortion. Replace if necessary.

4. Check all filter screens for dirt or lint. Clean and if they are distorted or plugged, replace with new parts.

5. Inspect cluster casting. If any parts in castings are loose or damaged, cluster assembly must be replaced.

6. Use new gaskets in reassembly.

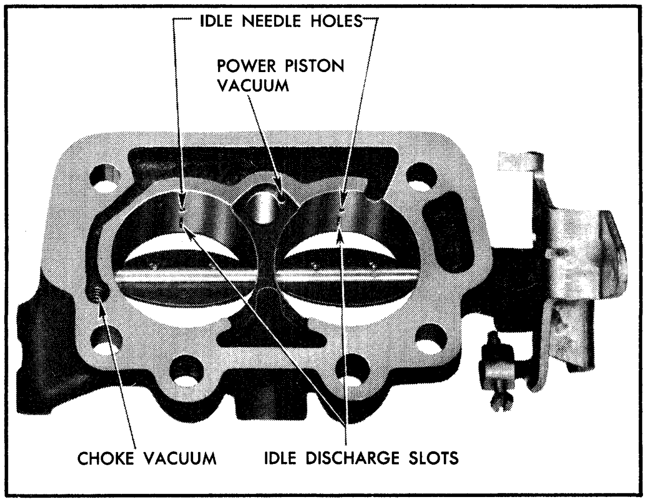



Fig. 6B-54 Passage Identification - Throttle Flange

### ASSEMBLY OF THROTTLE BODY

1. Install fast idle screw in throttle lever if removed.

2. Screw idle mixture and adjusting needles and springs into throttle body until finger tight. Back out screw 1-1/2 turns as a preliminary idle adjustment.

3. Upend bowl, place new throttle body gasket in position and attach throttle body. Tighten screws evenly and securely.

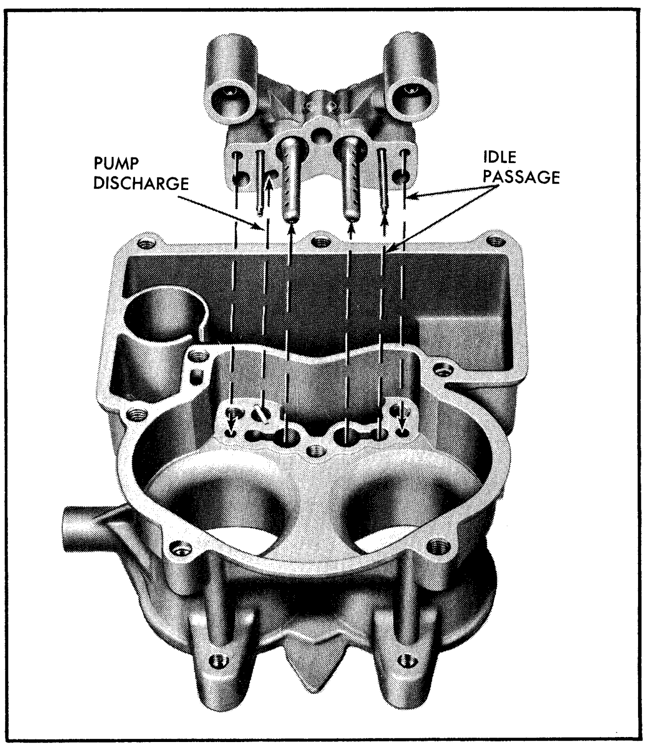



Fig. 6B-55 Passage Identification - Body to Cluster

*NOTE: Choke housing should be reassembled to throttle body after installing air horn.*

### ASSEMBLY OF BOWL

1. Install hot idle compensator on bowl section between venturi.

2. Drop steel pump discharge check ball into pump discharge hole. Ball is 3/16" diameter (do not confuse with aluminum intake ball). Install pump discharge spring and retainer.

3. Replace deflector (synchromesh), cluster and gasket, tighten screws evenly and securely. Make certain center screw is fitted with gasket to prevent pump discharge leakage.

4. Replace main metering jets and power valve.

5. Drop aluminum pump intake ball check into hole in pump well. Install pump return spring, pressing with finger to center it in pump well.

6. Replace pump inlet strainer, pressing carefully into position.

### ASSEMBLY OF BOWL COVER

1. Install choke shaft in air horn, then install choke valve on choke shaft using two attaching screws. Letters RP on choke valve should face towards top of air horn (Fig. 6B-56). Center choke valve before tightening screws, by installing the fast idle lever and choke trip lever. Maintain approximately .020" clearance between the fast idle lever and air horn casting. Then tighten choke valve screws and "stake" lightly. Then install choke trip lever and fast idle lever. Choke valve should move freely in housing.

2. Replace pump outer lever and shaft assembly and inner lever, tighten retaining screw on inner lever (Fig. 6B-57).

3. Install small fuel screen on needle seat.

4. Install float needle seat screen and gasket, using wide blade screwdriver.

5. Drop aluminum pump intake ball check into shaft end pointing inward towards center of air horn casting.

6. Install cover gasket.

7. Insert needle in seat, carefully position float and insert hinge pin.

8. Adjust float.

### FLOAT LEVEL ADJUSTMENT

With air horn inverted and gasket in place and needle seated, there should be 5/8" ± 1/16" clearance between the lower edge of float seam (sharp edge) at the toe end and air horn gasket (Fig. 6B-58).

Use gauge set J-8556. To adjust, bend float arm at rear of float. Visually check float alignment after adjusting float.

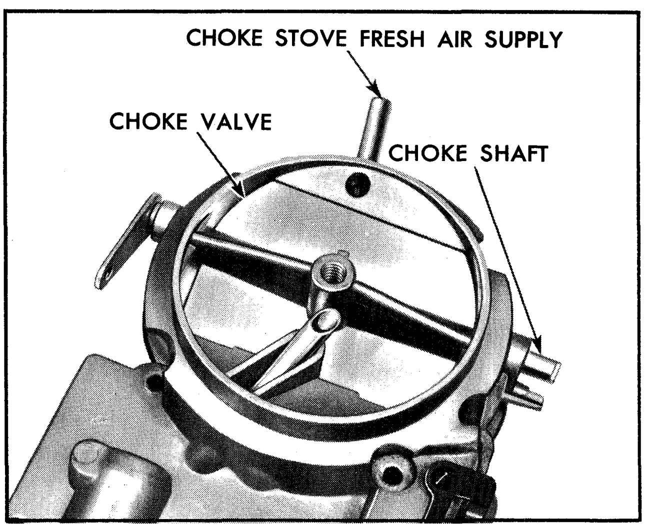



Fig. 6B-56 Choke Valve and Shaft Installed

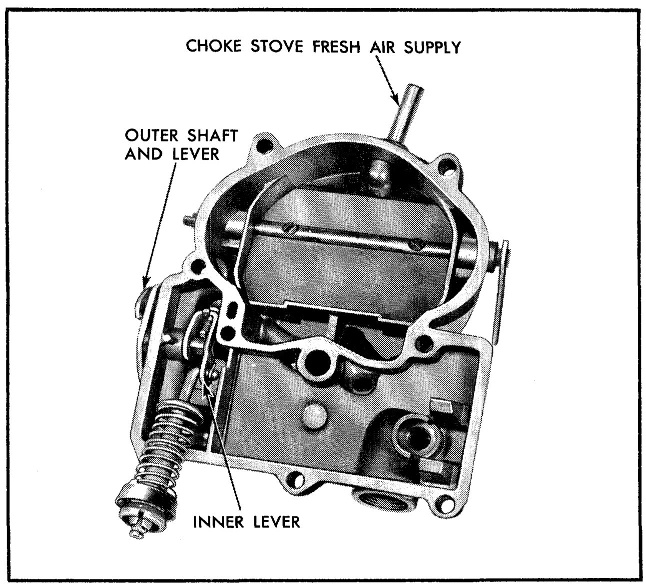



Fig. 6B-57 Pump Plunger Installed on Bowl Cover

### *FLOAT DROP ADJUSTMENT (Fig. 6B-59)*

With air horn right side up so that float can hang free, the distance from the gasket surface to the lowest point of the float should be a minimum of 1-3/4" (Fig. 6B-59). Maximum drop can be any amount that will retain needle for installation. Needle must not wedge at maximum drop. To adjust, bend tang at rear of float towards needle seat to decrease float drop and away from needle seat to increase float drop.

9. Install power piston in vacuum cavity; piston should travel freely in cavity. Stake vacuum piston retainer washer.

10. Place cover on bowl, making certain that accelerator pump plunger is correctly positioned and will move freely.

11. Install and tighten eight cover screws evenly and securely.

12. Install filter with closed end toward air horn.

13. Install pump link and retainer.

14. Install idle vent valve.

### *PUMP ROD ADJUSTMENT*

Place tool on top of cleaner mounting ring as shown in Fig. 6B-60. Then with throttle valves fully closed the top surface of the pump rod should just touch the end of the gauge. Measurement should be 1-21/64" ± 1/32". Bend pump rod to adjust.

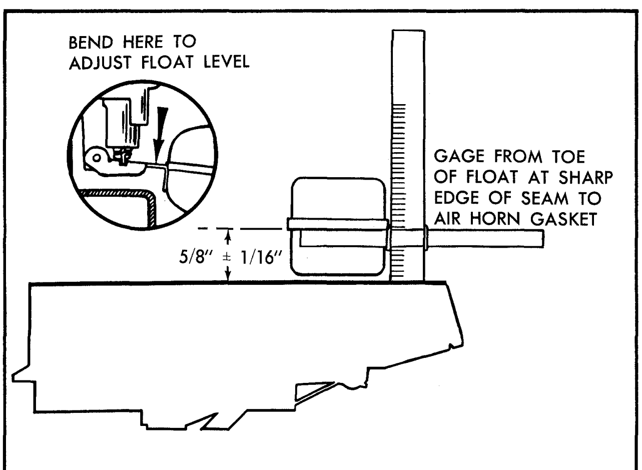



Fig. 6B-58 Float Level Adjustment

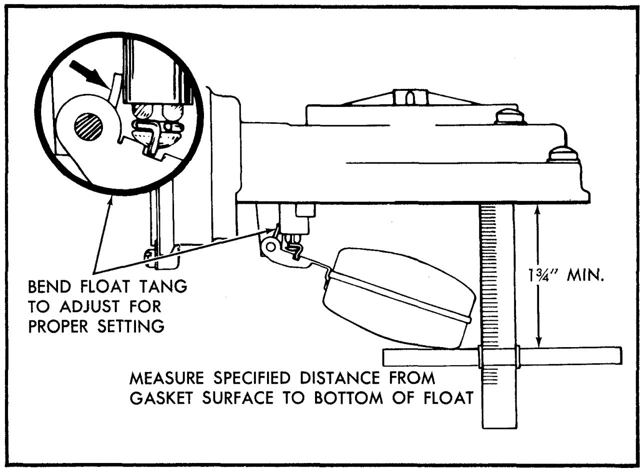



Fig. 6B-59 Float Drop Adjustment

16. Install fast idle link and fast idle cam as an assembly and install fast idle lever on other end of fast idle link. Place fast idle lever on choke shaft with the tank facing outward and toward the pump lever. Install trip lever so that tang of trip lever is under tang of choke lever, and install retaining screw (Figs. 6B-61 and 6B-62).

17. Assemble intermediate choke shaft and lever and new gasket to choke housing. Attach to throttle body with two attaching screws.

18. Assemble choke piston and linkage to choke housing and attach to intermediate choke shaft. Insert intermediate choke rod into lever on air horn and attach to intermediate choke lever with clip.

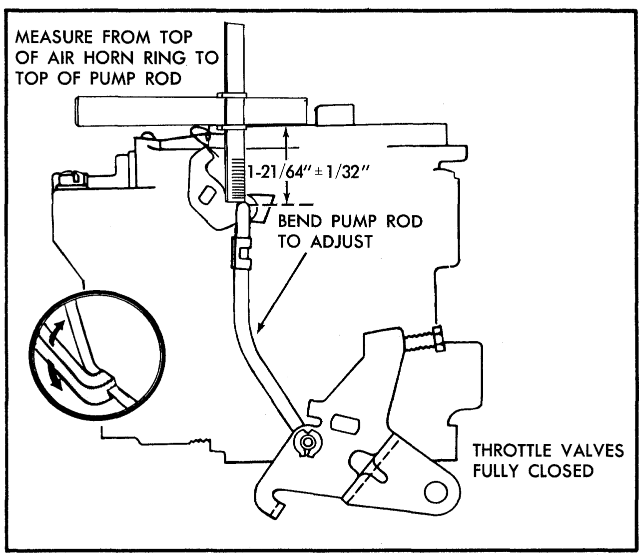



Fig. 6B-60 Pump Link Adjustment

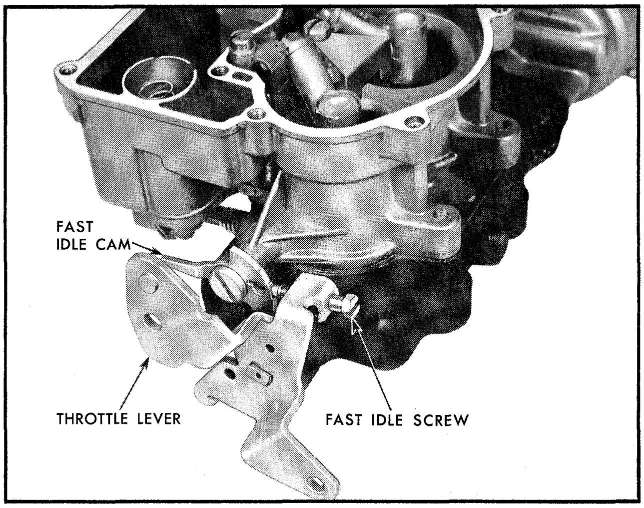



Fig. 6B-61 Fast Idle Cam Installed

19. Hold choke valve completely closed and adjust intermediate choke rod as necessary so that choke piston is flush with end of choke housing bore.

20. Install choke baffle plate.

21. Install choke coil and cover and rotate cover counterclockwise until the index marks on cover and housing are aligned. Attach the three retainers and screws to choke housing, tighten securely.

*NOTE: Choke valve should be lightly closed at room temperature (75°F.) when index marks on cover and housing are aligned.*

### CHOKE ROD ADJUSTMENT

1. With the thermostat cover set at index and the choke trip lever in contact with the fast idle lever, locate the fast idle screw on the second step of the fast idle cam, next to the shoulder of the high step.

2. Bend the tang on the fast idle lever so that the end of wire gauge or drill (.070" ± .010" automatic, .080" ± .010" synchromesh) just fits between the inner side of the air horn and the upper edge of the choke valve (Fig. 6B-63).

### IDLE VENT ADJUSTMENT

*NOTE: Pump rod setting must always be made before making the idle vent adjustment.*

With the idle vent valve just closed, bend the tang on the pump lever as necessary to obtain a dimension of 1-17/64" ± 1/64" between top of pump rod and top of air cleaner ring (Fig. 6B-64).

### UNLOADER ADJUSTMENT (Fig. 6B-65)

*NOTE: Unloader adjustment cannot be made correctly unless linkage is properly adjusted.*

1. Remove carburetor air cleaner assembly.

2. Depress accelerator pedal forcibly to floor. This should be done by person sitting in driver's seat of car to simulate driving conditions.) Check

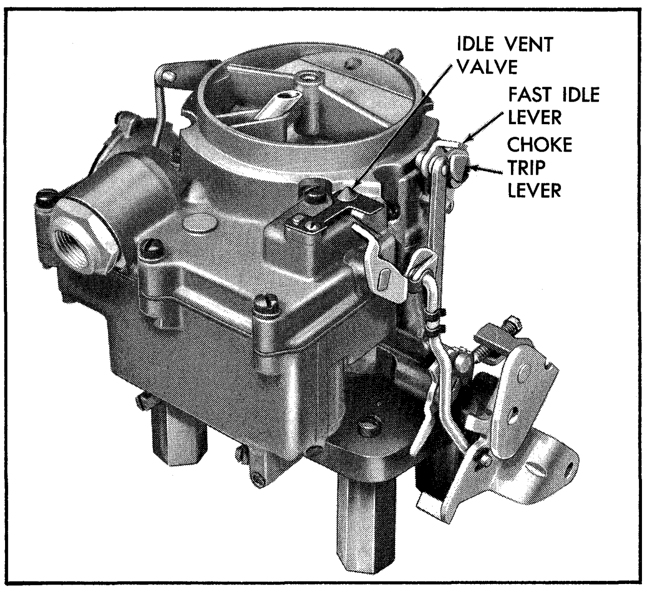



Fig. 6B-62 Carburetor Linkage Installed

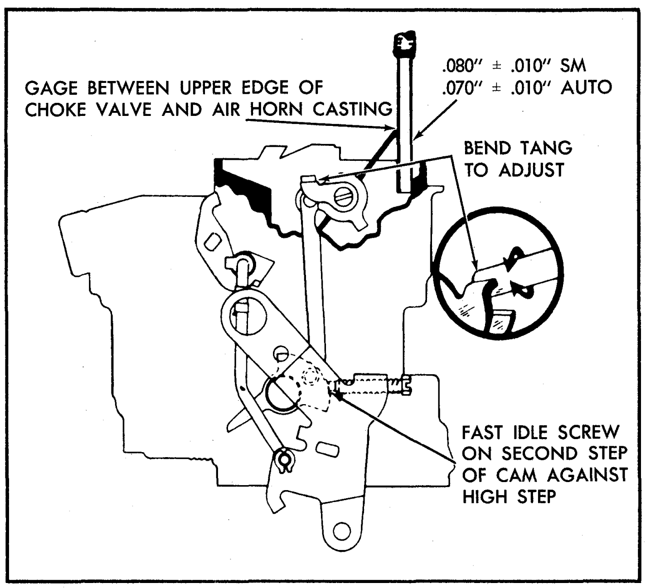



Fig. 6B-63 Choke Rod Adjustment

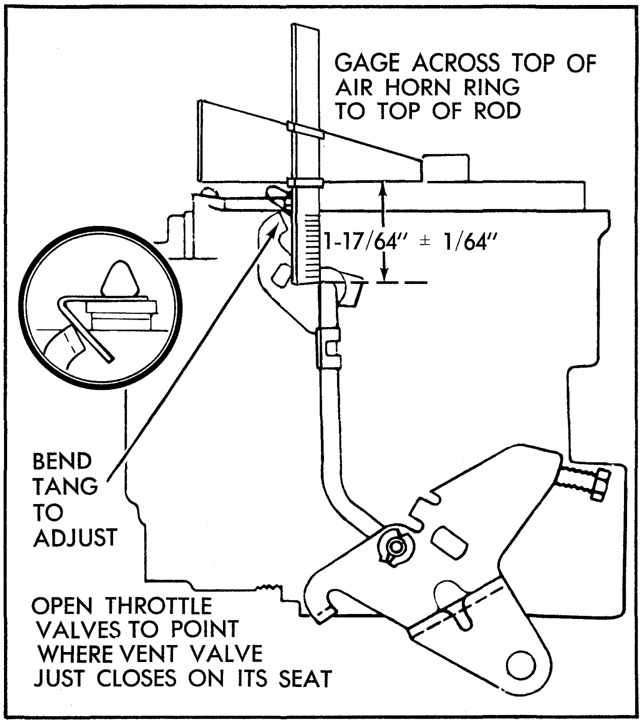



Fig. 6B-64 Idle Vent Valve Adjustment

to see that accelerator pedal is not hitting "hump" over transmission.

3. With accelerator pedal depressed as in Step 2, bend tang on throttle lever to give a clearance of

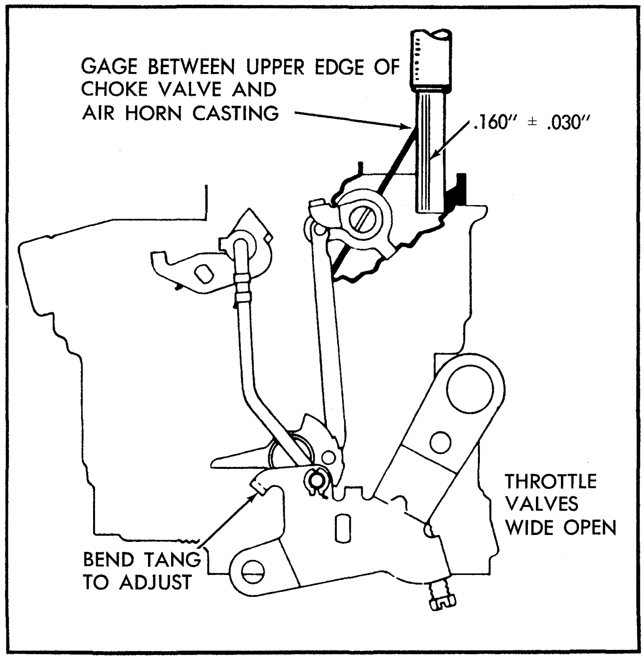



Fig. 6B-65 Unloader Adjustment

.160" ± .030" between the top of the choke valve and the inside of the air horn.

4. Replace air cleaner assembly.

The above procedure will eliminate variance in linkage, floor mat, pedal location, etc., and should ensure correct unloader action.

## CARTER AFB FOUR BARREL CARBURETOR

| Carburetor Model Number | Used On |
|---|---|
| 3687SA | Automatic Transmission V-326 H.O. Engine |
| 3686S | Synchromesh Transmission V-326 H.O. Engine |

### GENERAL DESCRIPTION

The Carter AFB (aluminum four barrel) carburetor used on V-326 H.O. engines is composed of two major assemblies, an air horn assembly and a combined throttle body and bowl called the body assembly. The air horn and body are made of cast aluminum.

The carburetor is basically two dual carburetors in one assembly. The half of the carburetor containing the step up rods, pump assembly and idle system is called the primary side of the carburetor. The other half is called the secondary side.

The carburetor contains the conventional carburetor circuits:

Float Circuits
Low Speed Circuits
High Speed Circuits
Pump Circuit
Choke Circuit

#### *FLOAT CIRCUIT (Fig. 6B-66)*

The purpose of the float circuit is to maintain the correct fuel level in the carburetor bowl at all times. The Carter AFB carburetor has two separate float circuits. Each float operates in its own float bowl and each bowl supplies fuel to a primary low speed circuit and to a primary and secondary high speed circuit. The two circuits operate identically.

When the fuel level in the bowl drops the float also drops allowing the needle to fall away from its seat.

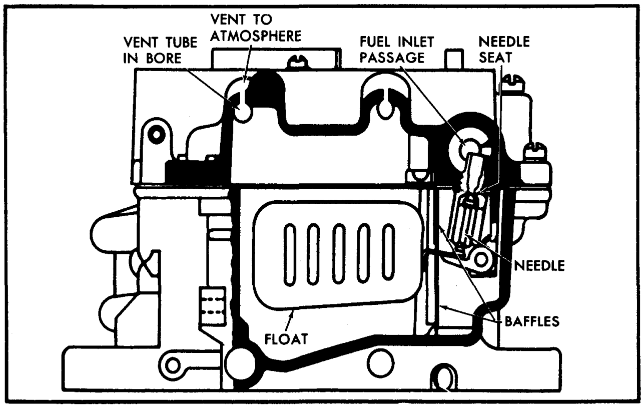



Fig. 6B-66 Float Circuit

Fuel at the fuel inlet under fuel pump pressure will then enter through the fuel filter past the needle and seat and into the float bowl. As the fuel level rises in the bowl the needle valve is seated cutting off the flow of fuel.

The intake needle seats are installed at an angle to give positive seating action of the intake needles. Intake needles and seats are carefully matched in manufacture and tested to ensure against fuel leakage. They should therefore always be used in pairs and not intermixed.

The bowl areas are vented to the inside of the air horn and to each other to ensure equal pressure on the surface of the fuel at all times and to allow the escape of fuel vapors. Baffles are used in the bowl area to minimize fuel turbulence.

### *LOW SPEED CIRCUITS (Fig. 6B-67)*

Fuel for idle and early part throttle operation is metered through the low speed circuits on the primary side of the carburetor. With the throttle valves closed, manifold vacuum exists at the idle needle port and idle discharge port. Atmospheric pressure will then force fuel through the primary metering jet and up through the low speed jet. The fuel picks up air at the bypass and is metered and broken up in the economizer passage. The fuel mixture then passes by another air bleed, down the idle passage and is discharged at the idle discharge port and the idle needle port.

The idle ports are slot-shaped. As the throttle valves are opened, more of the idle ports are uncovered allowing a greater quantity of fuel mixture to enter the carburetor bores. The secondary throttle valves remain closed at idle.

To aid in hot starting, vapor vents are provided in the throttle bores.

During hot idle the throttle valves are completely closed with the by-pass type carburetor. Idle air is directed around the throttle valves through the passage shown in Fig. 6B-68. The amount of air going through the passage is controlled by the air adjusting screw, thereby also controlling idle speed.

During long periods of idling with an extremely hot engine the fuel in the carburetor bowl becomes hot enough to form vapors. These vapors enter the carburetor bores by way of the inside bowl vents. The vapors mix with the idle air and are drawn into the engine causing an excessively rich mixture and

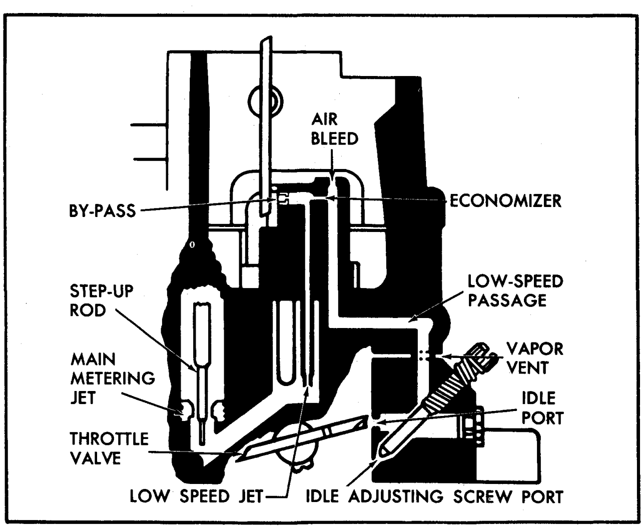



Fig. 6B-67 Low Speed Circuit

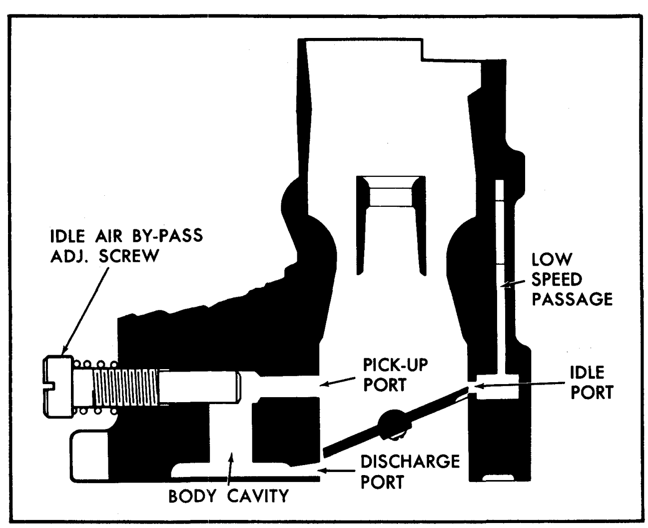



Fig. 6B-68 Idle Air By-Pass Circuit

a loss in rpm or engine stalling. Also, the decrease in the density of the air caused by extreme high under-hood temperatures reduces the idle speed.

The hot idle compensator (Fig. 6B-69) is calibrated to open under these temperature conditions, permitting additional air to enter the manifold below the secondary throttle valves (Fig. 6B-70) and mix with the fuel vapors providing a more combustible mixture. The engine rpm may still vary slightly, however, extreme rough idle operation and engine stalling are avoided.

The device is especially beneficial during traffic operation in very hot weather when the car is allowed to idle for a long period of time, particularly on air condition equipped automobiles. One of the other more common driving conditions that will bring the thermostatic valve into operation is when the car has been driven at highway speeds during a very hot day and then a line of traffic causes a delay where the engine must be run at idle speed, moving the car only a few feet at a time.

The valve is calibrated to open when the air temperature in the bore of the carburetor is between 128 and 140 degrees Fahrenheit with 15" vacuum applied to the valve seat. The operation of this valve cannot be checked accurately in field service, because of the difficulty of obtaining and measuring an accurate air temperature in the bore of the carburetor and the specified 15" of vacuum at the seat of the valve. In service, if any doubt exists concerning the operation of the valve, it should be replaced.

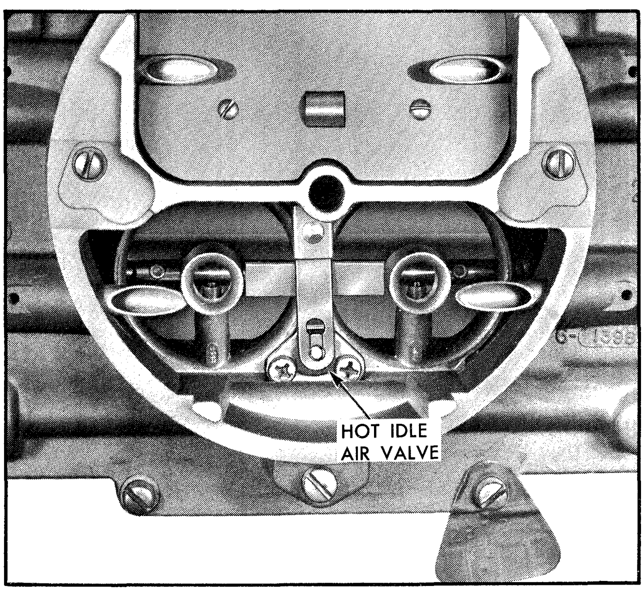



Fig. 6B-69 Hot Idle Air Valve

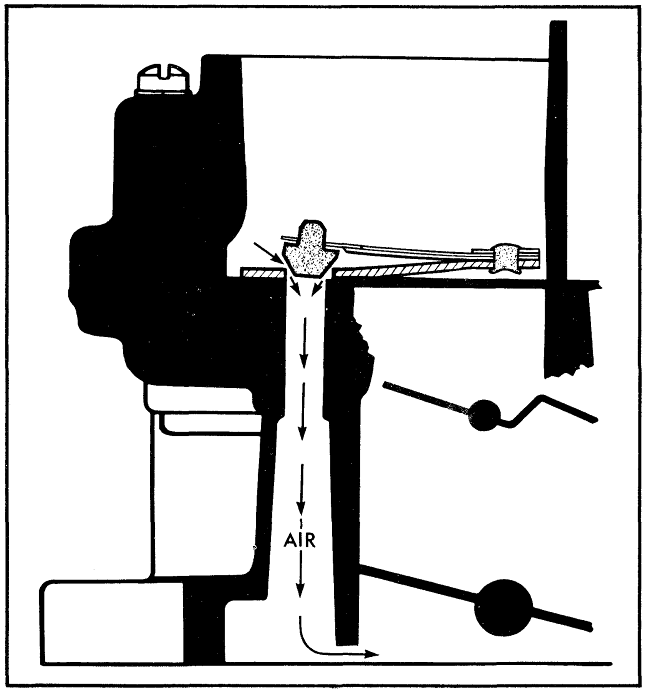



Fig. 6B-70 Hot Idle Air Valve Air Passage

A small hole through each primary throttle valve supplies idle air to supplement the air supplied through the by-pass idle air circuit. These supplementary air supply holes provide better adjustability and increase the idle air volume to provide sufficient idle speed on new engines.

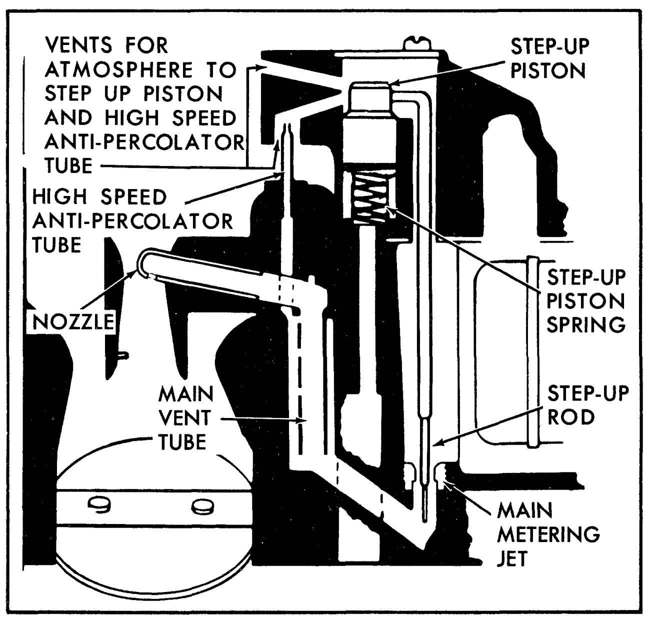



Fig. 6B-71 High Speed Circuit - Primary Side

### HIGH SPEED CIRCUIT—PRIMARY SIDE (Fig. 6B-71)

Fuel for late part throttle and full throttle operation is supplied through the high speed circuit.

As the throttle valves are opened air flow through the carburetor increases to the point that fuel is picked up at the discharge nozzles located in the main venturi. The pressure differential caused by the rapid flow of air through the venturi forces fuel through the primary metering jet up through the main vent tube. After picking up air at the air bleed the mixture is forced out through the main discharge nozzle. The air bleed in the high speed circuit also serves as an anti-percolator passage.

The amount of fuel delivered through the primary high speed circuit is dependent upon aid flow or throttle valve opening and by the position of the step-up rods in the primary main metering jets. The step-up rods are controlled entirely by manifold vacuum. When manifold vacuum is high the step-up rod piston and step-up rod are held downward, restricting the flow of fuel through the primary main metering jet. Under any operating condition that reduces manifold vacuum such as acceleration or hill-climbing the step-up rod piston spring raises the step-up rod positioning the smaller diameter or power step in the jet. This allows additional fuel to be metered through the jet. The step-up rods are not adjustable.

### HIGH SPEED CIRCUIT—SECONDARY SIDE (Fig. 6B-72)

The throttle valves in the secondary side remain closed until the primary throttle valves open a predetermined amount (approximately 55° of throttle opening). They arrive at the wide open position at the same time as the primary throttle valves.

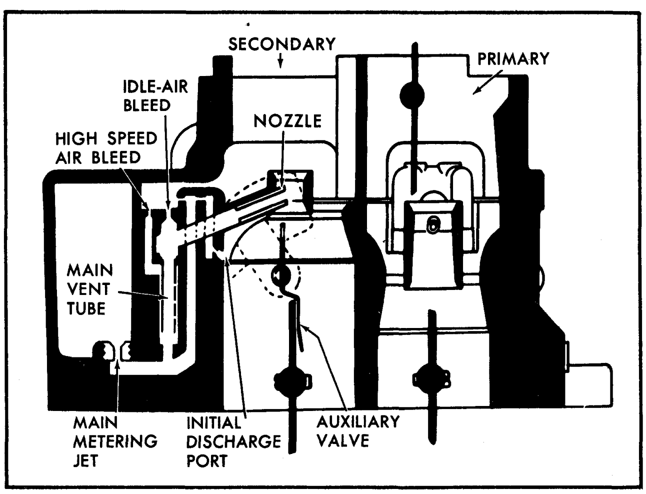



Fig. 6B-72 High Speed Circuit - Secondary Side

Mounted above the secondary throttle valves are the auxiliary throttle valves. These valves are opened by air flow and closed by counterweights. When the secondary throttle valves open, only the primary high speed circuit will function until there is sufficient air velocity to open the auxiliary throttle valves. When the auxiliary valves open, fuel will be supplied through the secondary high speed circuit.

Fuel for the secondary side is metered through the secondary main metering jets. No step-up rods are used.

To supplement the starting of the secondary high speed circuit an initial discharge system is used. Initial discharge ports are located next to the venturi struts. When the auxiliary valves start to open, a low pressure area results at these ports and atmospheric pressure forces fuel into the initial discharge passage. Air is picked up at the air bleed and the mixture enters the air stream at the initial discharge ports. As the auxiliary valves continue to open and the secondary nozzles begin to function, pressure increases at the discharge ports and their operation diminishes. An acceleration tube is used to smooth the transition from two to four barrel operation on acceleration.

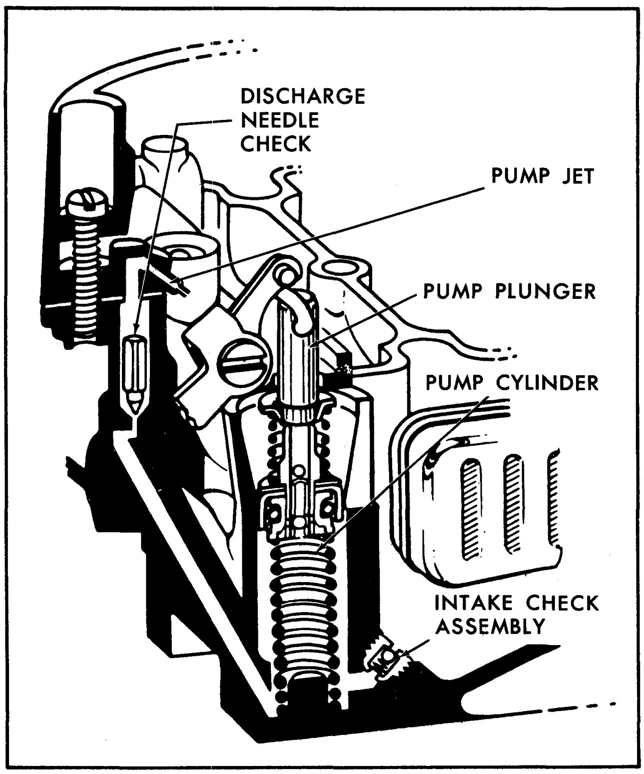



Fig. 6B-73 Pump Circuit

### *PUMP CIRCUIT (Fig. 6B-73)*

The accelerating pump circuit located in the primary side provides for a measured amount of fuel to be discharged into the carburetor throat during acceleration from low car speeds. A rapid opening of the throttle valves, as is the case when accelerating from low speeds, causes an immediate increase in air velocity. Since fuel is heavier than air it requires a short period of time for it to "catch up" with the air flow. To avoid a leanness during this momentary lag, the accelerator pump furnishes a quantity of liquid fuel, sprayed into the air stream to mix incoming air and maintain the proper fuel-air mixture. The pump is operated by the combined action of two springs which are calibrated to move the plunger in such a manner that a sustained charge of fuel is delivered for smooth acceleration.

The pump is attached by linkage to the accelerator so that when the throttle valves are closed the pump plunger moves upward in its cylinder creating a low pressure area (partial vacuum) in the cylinder below the plunger. Atmospheric pressure acting on the fuel in the bowl forces fuel into this cylinder through the intake ball check. The discharge needle is seated at this time to prevent air being drawn into the cylinder.

When the throttle is opened, the friction of the plunger in the cylinder and the tension of the lower plunger spring resists the downward movement of the pump plunger causing the plunger shaft to telescope. This compresses the upper spring. The upper spring then overcomes the resistance and pushes the plunger down. However, the speed of the plunger is retarded by the lower spring so that a sustained charge of fuel is released into the system. The movement of the plunger exerts a pressure in the cylinder which seats the intake ball check preventing fuel from being forced back into the bowl. The same pressure also forces fuel up the discharge passage, unseating the pump discharge needle, and on through the pump jets in the cluster where it is sprayed into the carburetor throat.

At higher speeds, pump discharge is no longer necessary to insure smooth acceleration. When the throttle valves are opened a predetermined amount, the pump plunger bottoms in the cylinder eliminating pump discharge.

During high speed operation, a vacuum exists at the pump discharge ports. To prevent atmospheric pressure from forcing fuel to these ports and into the system, the pump jets are vented. This allows air

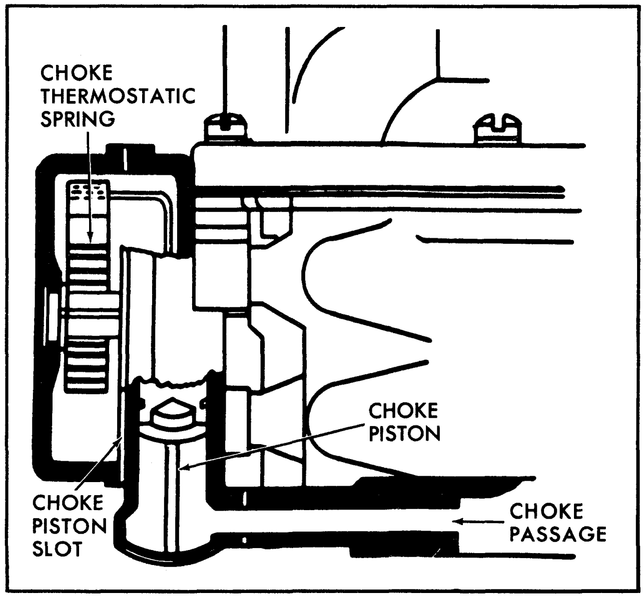



Fig. 6B-74 Choke Circuit

instead of fuel to be forced through the discharge ports.

An "anti-percolator" check valve, contained inside the plunger, provides relief for any vapors which might form during hot idle or when a hot engine is not operating. The ball check is designed so that it can move up and down in its passage. Throughout the above periods it is unseated by gravity and vapors in the pump well rise and by-pass the ball check through small holes in the plunger head.

The "anti-perc" ball check also acts as an extra inlet during the upstroke of the plunger, but is seated by fuel when the plunger moves down.

### *CHOKE CIRCUIT (Fig. 6B-74)*

The purpose of the choke system is to provide a very rich mixture for cold engine operation.

The choke system subjects all fuel outlets in the bore of the carburetor to manifold vacuum while restricting the intake of air.

The choke system includes a thermostatic coil, housing, choke piston, choke valve, source of fresh air supply to the choke stove, and fast idle cam and linkage. It is controlled by a combination of intake manifold vacuum, air velocity against the offset choke valve, atmospheric temperature and hot air from the intake manifold.

When the engine is cold, tension of the thermostatic coil holds the choke valve closed. Starting the engine causes air velocity to strike the offset choke valve. This tends to open it along with the action of intake manifold vacuum on the choke piston. Thus, after a slight opening of the choke valve, the tension of the thermostatic coil spring balances the force of air on the valve and the pull of vacuum at the piston.

At the cold idle position, slots located in the sides of the choke piston cylinder are uncovered, exposing them to intake manifold vacuum. Air, heated in a tube running through the exhaust cross-over passage in the intake manifold, then fills this low pressure area in the choke housing. The flow of warm air heats the thermostatic coil and causes it to lose its tension until full choke valve opening is accomplished. The clean air is supplied to the choke in the manifold from the air horn, just below the air cleaner. Here filtered air from the air cleaner is picked up and carried to the choke by a metal pipe.

A secondary baffle plate is located in the choke housing to distribute the warm air evenly over the thermostatic coil thereby insuring gradual relaxation of the coil. The baffle revolves with the choke valve and prevents the warm air from striking the thermostatic coil until the choke valve opens a predetermined amount. This delays choke opening.

If the engine is accelerated during the warm-up period, the corresponding drop in manifold vacuum allows the thermostatic coil to momentarily close the choke, providing a richer mixture.

To combat engine stalling during warm-up on cool, humid days, caused by "carburetor icing", heated air from the choke housing is circulated through a passage in the base of the carburetor flange.

During the warm-up period, it is necessary to provide a fast idle to prevent engine stalling. This is accomplished by a fast idle cam connected to the choke shaft. The fast idle adjusting screw on the throttle lever contacts the fast idle cam and prevents the throttle valves from returning to a normal warm engine idle position until the choke is open.

If during the starting period, the engine becomes flooded the choke valve can be partially opened manually to allow increased air flow through the carburetor. This is accomplished by depressing the accelerator pedal forcibly to the floor and engaging the starter. The unloader projection on the throttle lever contacts the unloader lug on the fast idle cam and in turn partially opens the choke valve.

## ADJUSTMENTS ON CAR

All Carter adjustments can be performed on the car. All adjustments are included in the "Overhaul and Adjustments" procedure, with the exception of the idle speed and mixture adjustment, fast idle adjustment, and the unloader adjustment. Following are the idle speed, mixture, and the unloader adjustments.

### IDLE SPEED AND MIXTURE ADJUSTMENT

1. As a preliminary setting turn air screw out 1-1/2 turns from lightly seated position and mixture screws out 1 turn.

2. Set hand brake securely, place transmission in neutral and connect tachometer to engine.

3. Start engine and warm up thoroughly. Make sure choke is fully open and carburetor is completely off fast idle.

*CAUTION: When adjusting idle make sure hot idle compensator is held manually closed during adjustment.*

4. Adjust the air screw to obtain correct idle rpm. (Use drive range on automatic transmission equipped cars.)

5. Turn mixture screws to best quality (highest rpm) idle.

6. Reset air screw to correct rpm if mixture adjustment changed setting.

7. Recheck mixture adjustment to insure smoothest possible idle.

*NOTE: Always recheck idle mixture setting after making idle rpm adjustment with air screw.*

### IDLE SPECIFICATIONS

| | |
|---|---|
| Synchromesh, exc. air conditioning . | 580-600 rpm |
| Automatic, exc. air conditioning . . . | 480-500 rpm in drive range |
| Air Conditioning Equipped | |
| Automatic - Drive-range, A/C off . | 540-560 rpm |
| S/M - Neutral, A/C off . . . . . . . | 640-660 rpm |

### FAST IDLE ADJUSTMENT

The fast idle setting must be made after the idle speed and mixture adjustment has been made. With the engine completely warmed up and the fast idle screw on highest step of fast idle cam, set fast idle screw to give an engine speed of 2500 rpm.

### UNLOADER ADJUSTMENT

1. Remove carburetor air cleaner assembly.

2. Depress accelerator pedal forcibly to floor. (This should be done by person sitting in driver's seat of car to simulate driving conditions.)

3. With accelerator pedal depressed as in step 2, bend tang on throttle lever to give a clearance of 5/32" ± 1/32" between the top of the choke valve and the inside of the air horn.

4. Replace air cleaner assembly.

The above procedure will eliminate variance in linkage, floor mat, pedal location, etc. and should ensure correct unloader action.

## OVERHAUL AND ADJUSTMENT

### DISASSEMBLY OF AIR HORN

1. Place carburetor on stand J-5923 or J-8328 and remove inlet nut, gasket and filter.

2. Remove throttle connector rod and anti-rattle spring.

3. Remove fast idle connector rod at upper end (Fig. 6B-75).

4. Remove choke connector rod (Fig. 6B-76).

5. Remove two step-up piston cover plate attaching screws and cover plates (Fig. 6B-76).

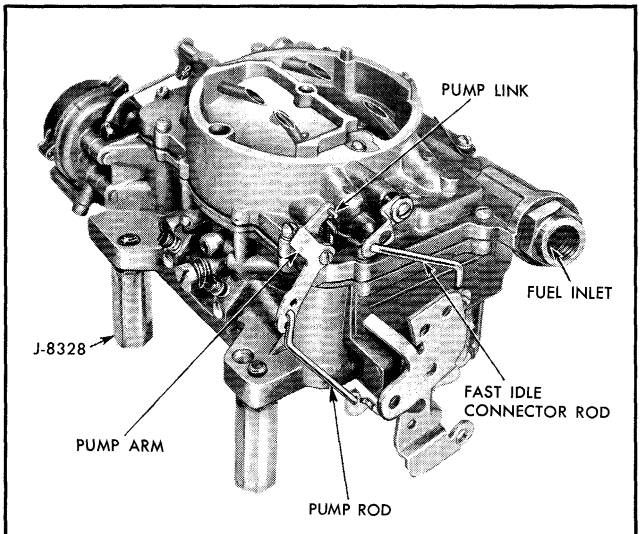



Fig. 6B-75 Carter AFB Carburetor

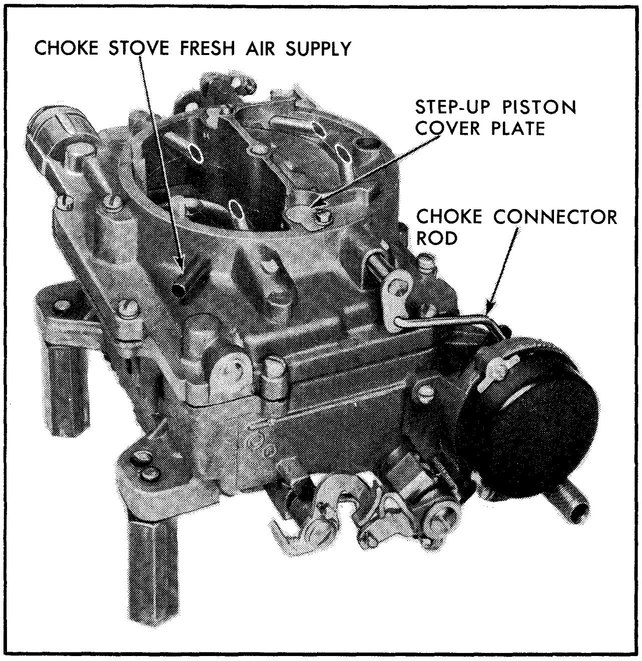



Fig. 6B-76 Carter AFB Carburetor

6. Remove two step-up rods and step-up pistons. If desired, step-up rod may be separated from piston by unhooking step-up rod retaining spring from end of rod (Fig. 6B-77). Remove two step-up rod piston springs.

7. Remove choke shaft lever retainer screw, choke shaft lever and washer from end of choke shaft.

8. Remove two choke valve attaching screws and choke valve.

9. Remove ten air horn attaching screws and lift off air horn assembly.

10. Slide choke shaft from air horn.

11. Remove pump arm and link and pump plunger assembly.

12. Remove float hinge pin, float and float needle assembly on inlet side of carburetor (Fig. 6B-78).

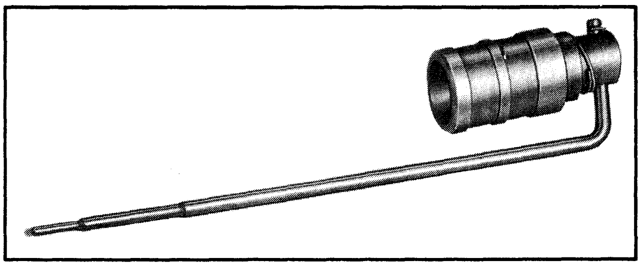


Fig. 6B-77 Step Up Rod and Piston Assembly

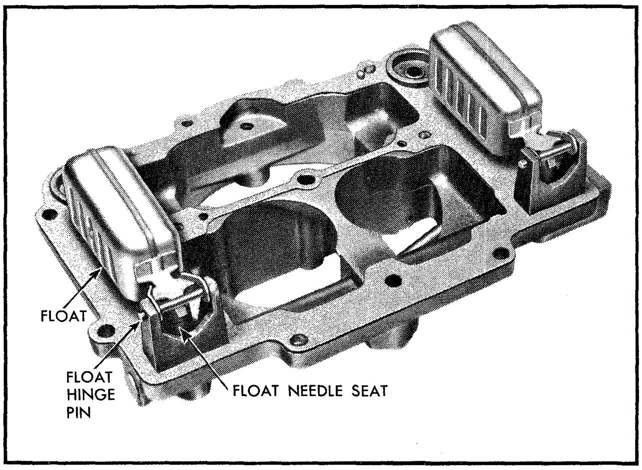



Fig. 6B-78 Air Horn Assembly

13. Remove float needle seat and gasket using wide blade screwdriver.

*NOTE: Keep individual float parts grouped so the same needle and seat are used together.*

14. Remove remaining float hinge pin, float, float needle, float needle seat and gasket.

15. Remove air horn gasket.

### DISASSEMBLY OF THROTTLE BODY

1. Remove three choke coil housing attaching screws and choke coil housing and thermostatic coil.

2. Remove coil housing gasket and baffle plate.

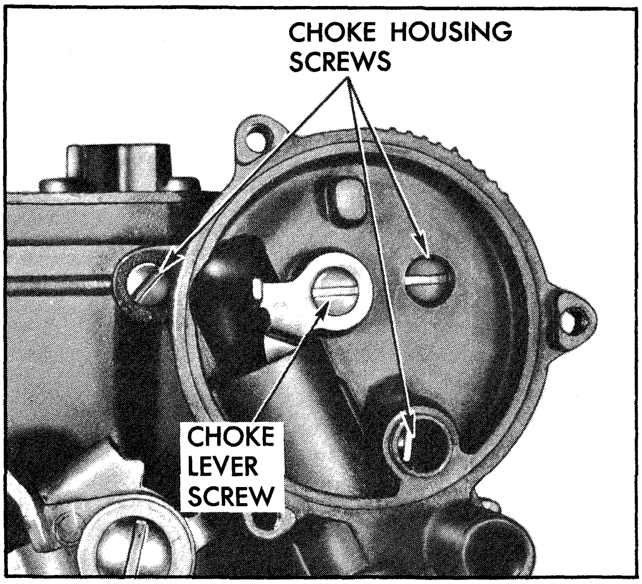



Fig. 6B-79 Location of Choke Housing Screws

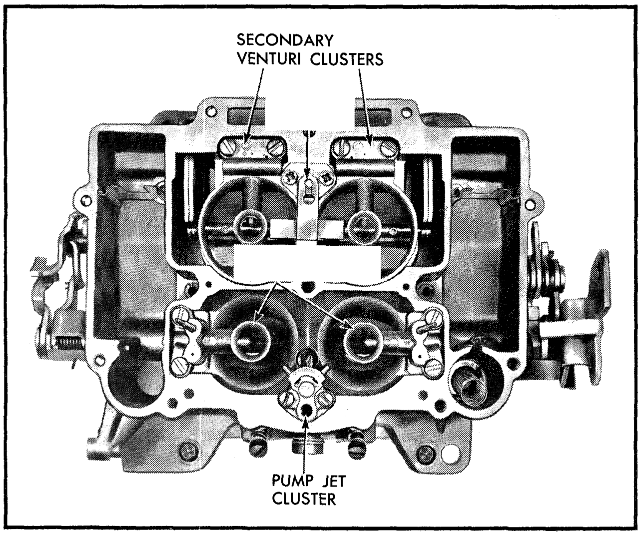



Fig. 6B-80 Top View of Carburetor Body Assembly

3. Remove choke lever attaching screw. (Fig. 6B-79). Remove choke piston, lever and link assembly by rotating piston from bore.

4. Remove three choke housing to body attaching screws (Fig. 6B-79) and remove choke housing and gasket.

5. Remove lower choke lever and shaft from choke housing.

6. Remove pump jet cluster and gasket. (Fig. 6B-80).

7. Remove two screws and primary venturi and gasket on pump side (Fig. 6B-80).

8. Remove two screws and primary venturi and gasket on choke side.

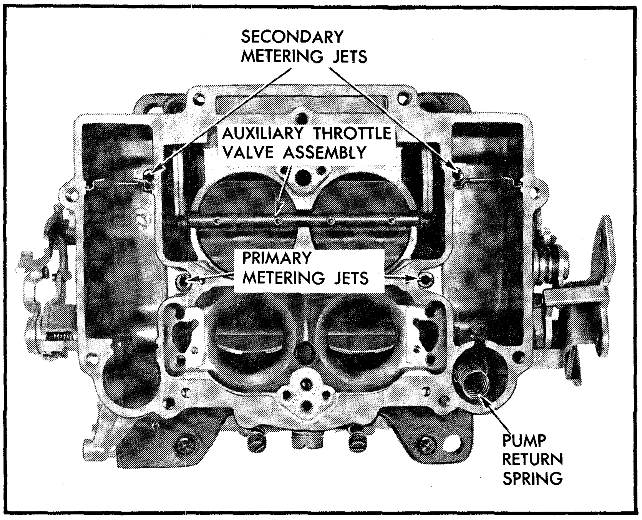



Fig. 6B-81 Body Assembly with Cluster Removed

*NOTE: The venturi assemblies are not interchangeable.*

9. Remove hot idle air valve and gasket.

10. Remove secondary venturi on pump and choke sides (Fig. 6B-80).

11. Lift out auxiliary throttle valve, shaft and weight assembly (Fig. 6B-81).

12. Remove two primary metering jets.

13. Remove two secondary metering jets.

14. Remove pump return spring.

15. Remove pump intake check.

16. Remove idle mixture screws.

17. Remove air screw.

18. Carefully invert carburetor body and remove pump discharge check needle.

19. Remove throttle lever adjusting screw and spring.

20. Remove fast idle cam attaching screw, fast idle cam, trip lever and lockout lever (Fig. 6B-82).

21. Remove primary to secondary throttle operating rod (Fig. 6B-83).

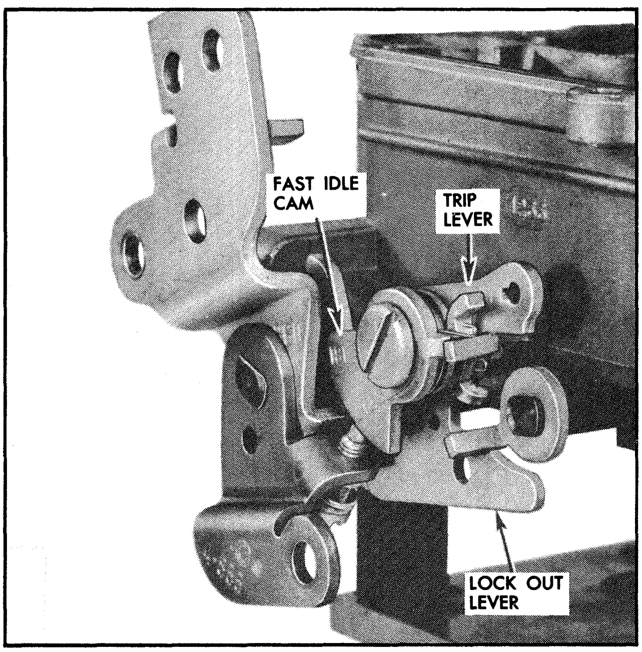



Fig. 6B-82 Location of Fast Idle Cam and Lockout Lever

22. Remove screw, secondary throttle shaft washer and secondary throttle operating lever and spring.

23. Unhook throttle flex spring from primary outer throttle shaft arm.

24. Remove primary throttle shaft lever attaching screw and washer from primary throttle shaft.

25. Remove outer throttle shaft arm and throttle shaft dog (Fig. 6B-83).

26. Remove inner throttle shaft arm and flex spring.

27. If necessary to remove throttle shafts remove throttle valve attaching screws, throttle valves and slide shaft from carburetor body.

28. Remove fast idle adjusting screw if necessary to replace.

### CLEANING AND INSPECTION

Dirt, gum, water or carbon contamination in the carburetor or on the exterior moving parts of a carburetor are often responsible for unsatisfactory performance. For this reason, efficient carburetion depends upon careful cleaning and inspection while servicing.

1. Thoroughly clean carburetor castings and all metal parts in clean carburetor cleaning solution.

*CAUTION: Composition and plastic parts such as pump plunger and gaskets should not be immersed in cleaner.*

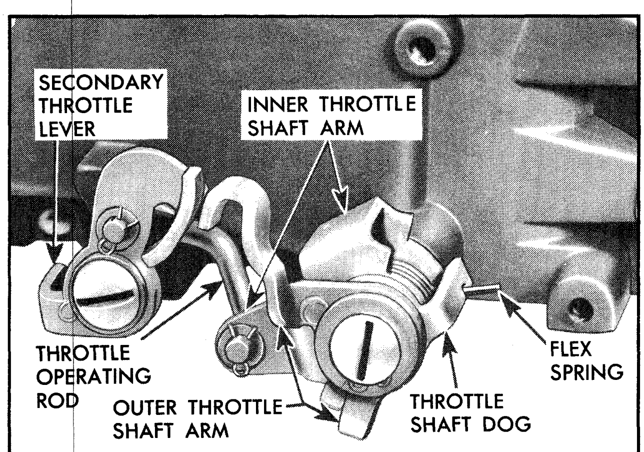



Fig. 6B-83 Primary and Secondary Throttle Linkage

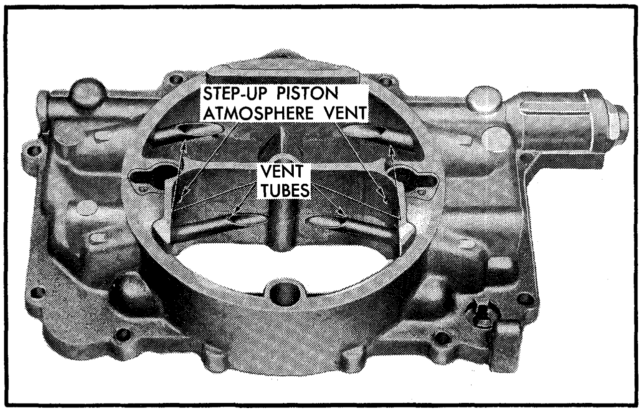



Fig. 6B-84 Passage Identification - Air Horn

2. Blow out all passages (Figs. 6B-84, 85, 86, 87, and 89) in casting with compressed air and blow off all parts to ensure they are free of cleaner.

*NOTE: Follow instruction furnished with cleaning solution container.*

*CAUTION: Do not use drills or wire to clean out jets or ports as this may enlarge the opening and affect carburetor operation.*

3. Carefully inspect parts for wear and replace those which are worn, checking the following specific points:

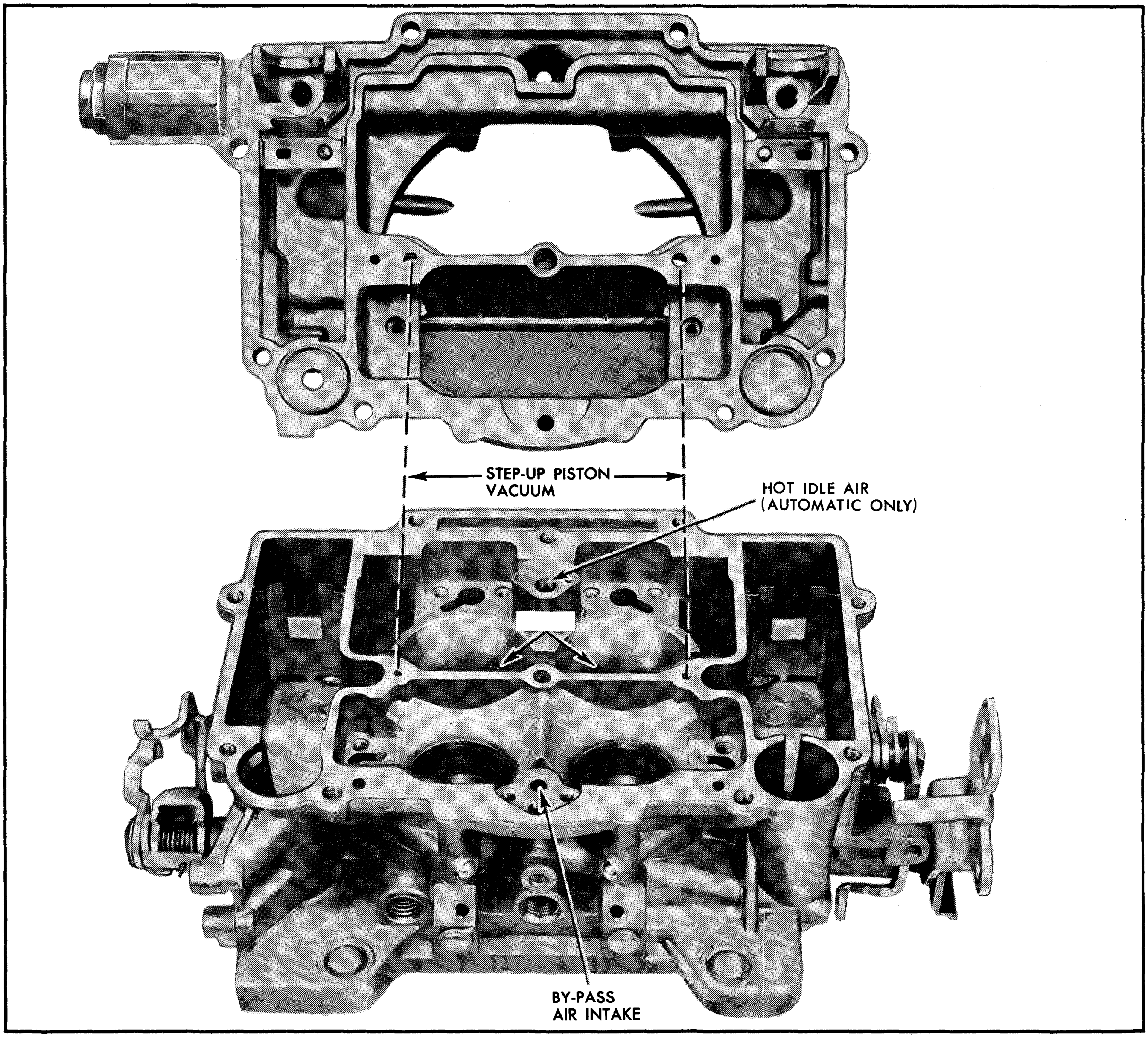



Fig. 6B-85 Passage Identification - Air Horn to Body

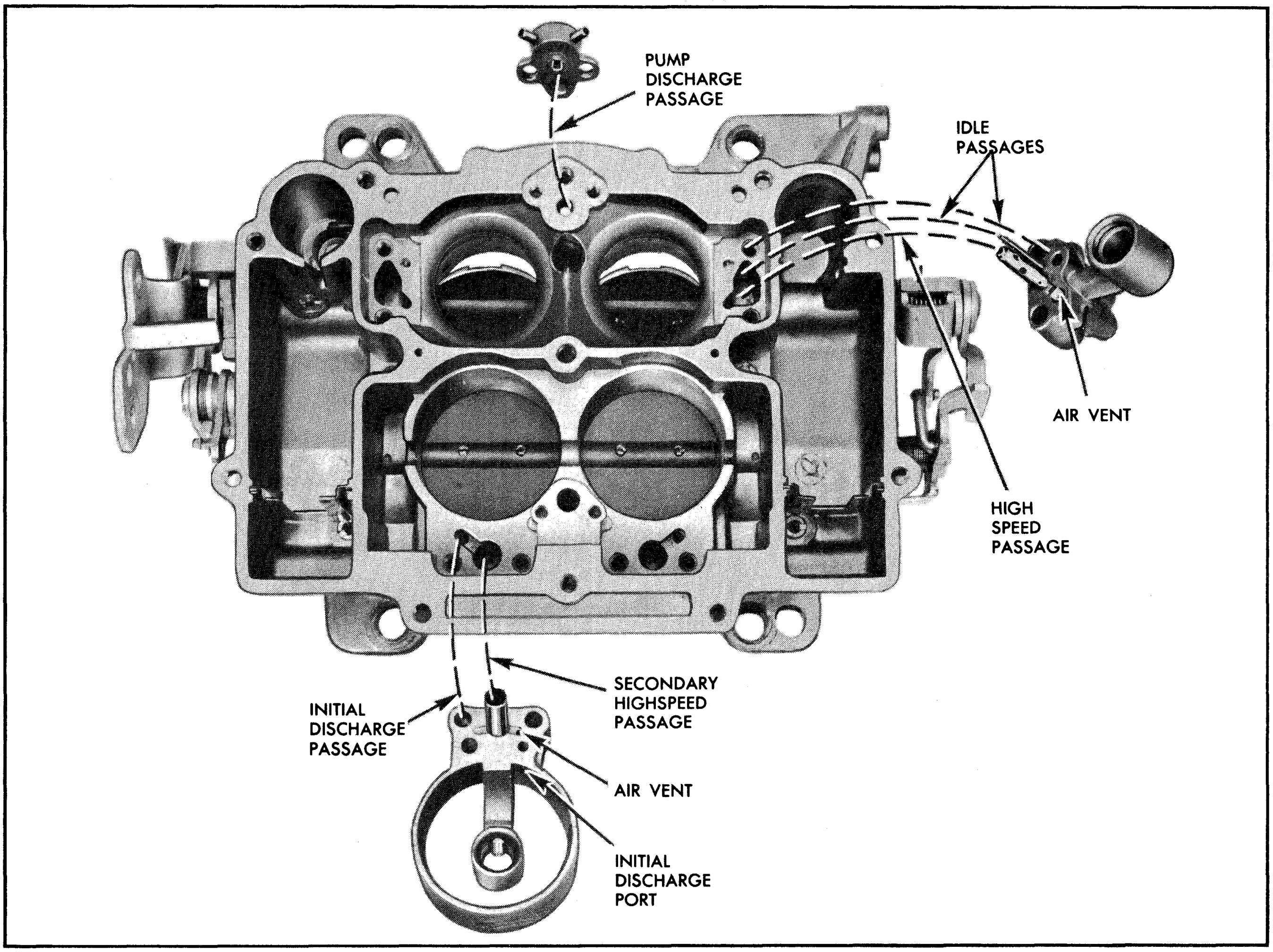



Fig. 6B-86 Passage Identification - Clusters to Body

a. Inspect choke piston and choke piston housing for carbon and gum. If necessary to clean choke piston housing, remove Welch plug in the bottom of housing. Plug can be removed by piercing center with a small pointed instrument and prying outward. Care should be exercised so that damage will not result to the casting when removing this plug. Before installing new plug, carbon present in piston cylinder slots should be removed and the Welch plug seat should be carefully cleaned.

b. Remove carbon from bores of throttle flange.

c. Inspect float needles, and seats for wear; if leaking, both needle and seat must be replaced.

d. Inspect float pins for excessive wear.

e. Inspect floats for dents and excessive wear on lip. Check for fluid inside floats by shaking. Replace float if any of above are present.

f. Inspect throttle shafts for excessive wear (looseness or rattle in body flange casting).

g. Inspect idle mixture adjusting screws for burrs. Replace if burred or scored.

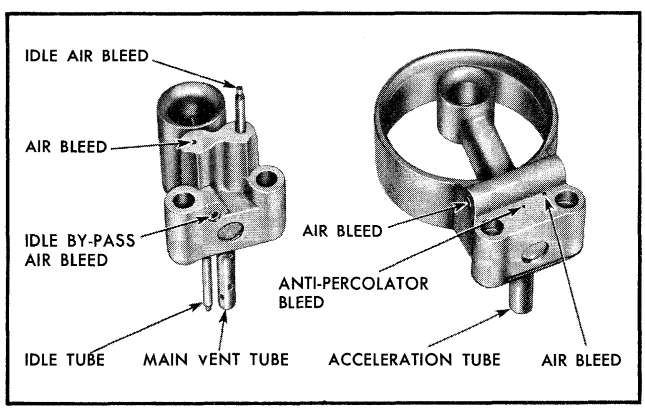



Fig. 6B-87 Passage Identification - Primary and Secondary Venturi Clusters

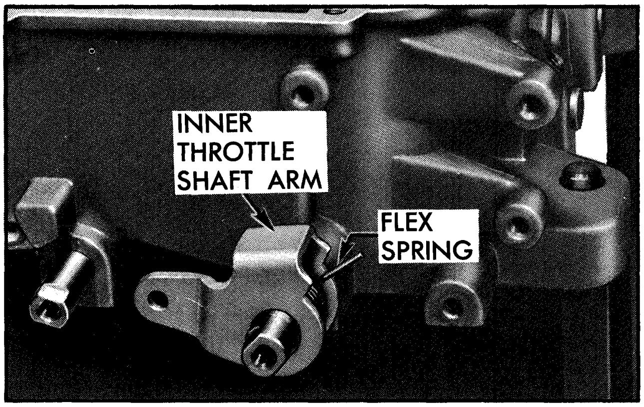



Fig. 6B-88 Inner Throttle Shaft Arm and Flex Spring Installed

h. Inspect pump plunger assembly. If leather is not in good condition, replace plunger.

i. Inspect gasketed surfaces between body and air horn, and between body and flange. Small nicks or burrs should be smoothed down to eliminate air or fuel leakage. Be especially particular when inspecting choke vacuum passage and the top surface of the inner wall of the bowl.

j. Inspect holes in pump rocker arm, fast idle cam and throttle shaft lever. If holes are worn excessively or out of round to the extent of causing improper carburetor operation, the part should be replaced.

k. If excessive wear is noted on fast idle cam, it should be replaced to ensure proper engine operation during warm up.

l. Check all filter screens for lint or dirt. Clean or replace as necessary.

m. Check venturi clusters for loose or damaged parts. If damage or looseness exists, replace cluster assembly.

### ASSEMBLY OF THROTTLE BODY

1. If throttle shafts were removed during disassembly insert shafts through body with lever ends on pump side of body.

2. Using new screws install primary and secondary throttle valves so that trade mark (c in circle) is visible from the bottom of body with throttle valves closed.

3. Install fast idle adjusting screw.

4. Place carburetor body on stand.

5. Install pump intake check.

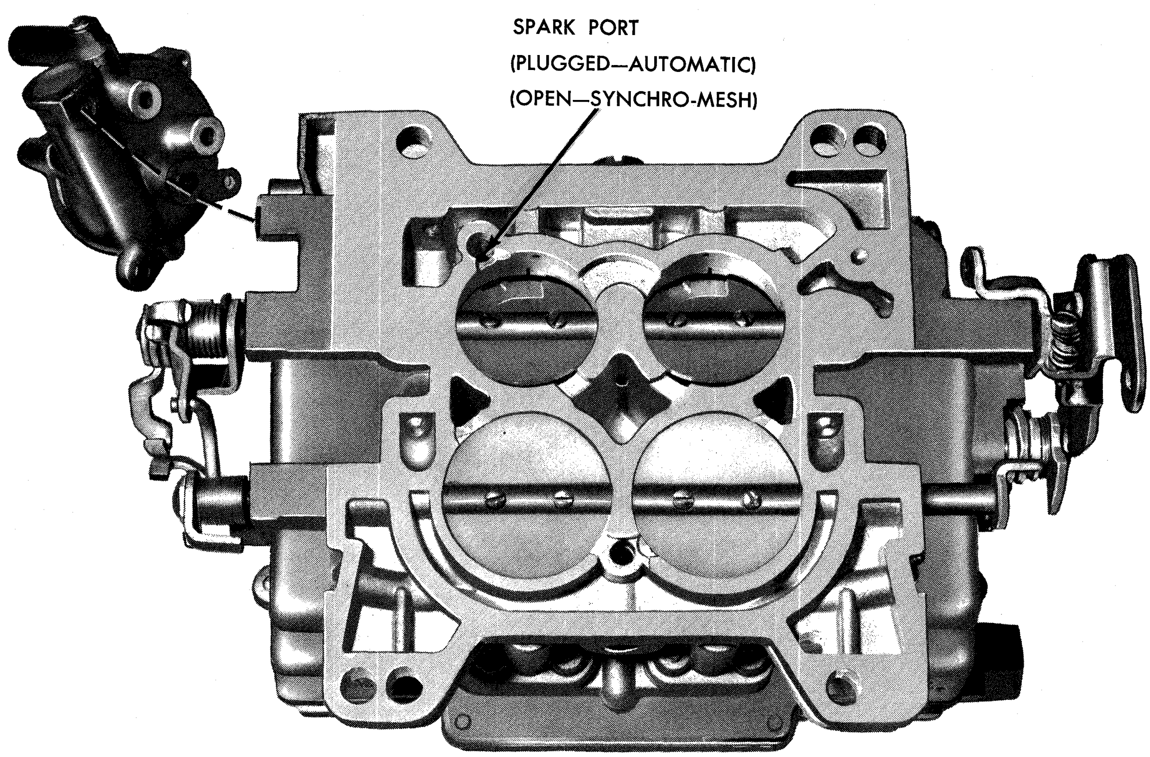



Fig. 6B-89 Passage Identification - Flange Area of Body

6. Install inner throttle shaft arm and flex spring on primary throttle shaft (Fig. 6B-88).

7. Install throttle shaft dog on primary throttle shaft (Fig. 6B-90).

8. Install outer throttle shaft arm, washer and retaining screw on primary throttle shaft (Fig. 6B-91).

9. Hook end of flex spring into notch on outer throttle shaft arm.

10. Install secondary throttle operating spring, lever, washer and screw (Fig. 6B-91). Wind spring two turns tight.

11. Install throttle operating rod, washers and spring clips.

12. Install lockout dog, trip lever, fast idle cam and screw (Fig. 6B-92).

13. Install throttle lever screw and spring.

14. Install idle mixture screws. Turn in finger tight and back out one turn for approximate adjustment.

15. Install air screw. Turn in finger tight and back out 1-1/2 turns for approximate adjustment.

16. Install primary metering jets and secondary metering jets in their respective bores.

17. Set auxiliary throttle valves in place.

18. Install secondary venturi and gaskets on choke and pump sides.

19. Install hot idle air valve and gasket.

20. Install primary venturi and gaskets on choke and pump side of carburetor (Fig. 6B-93).

21. Install pump discharge check needle, point down and pump jet cluster and gasket with two screws.

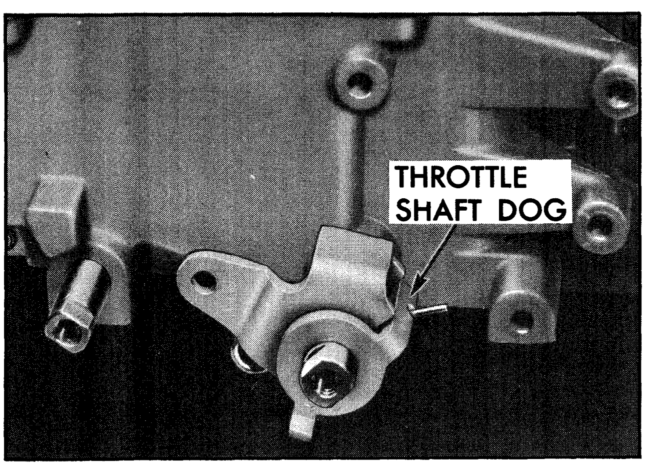



Fig. 6B-90 Throttle Shaft Dog Installed

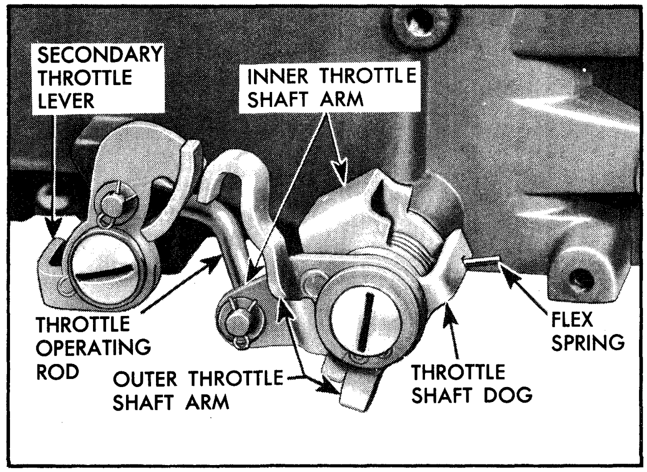



Fig. 6B-91 Primary and Secondary

22. Install pump plunger return spring in pump bore.

23. Install lower choke shaft and lever in choke housing and attach choke housing and gasket to carburetor body and three self-tapping screws.

24. Install choke piston and link assembly in choke housing.

25. Attach choke piston linkage to lower choke shaft with screw and spacer washer.

*NOTE: Before proceeding with next step perform choke piston lever adjustment.*

26. Install choke baffle plate, cover gasket, and choke cover and spring assembly. Set choke at one notch rich.

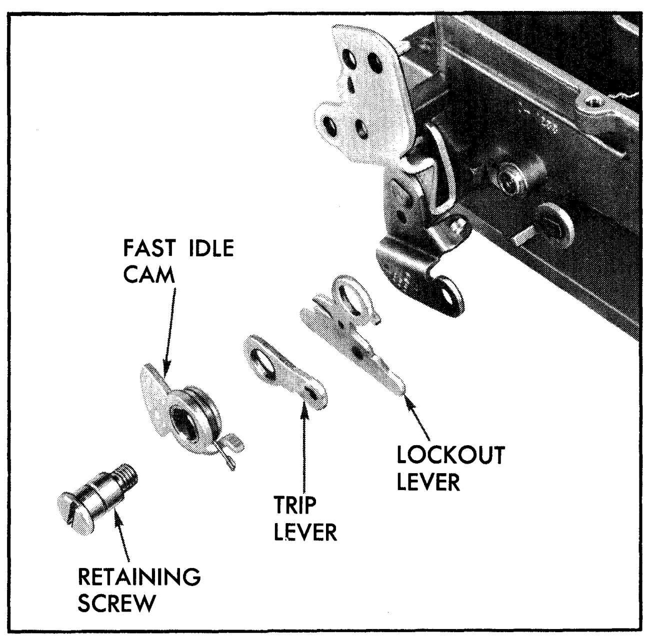



Fig. 6B-92 Lockout Lever and Fast Idle Cam

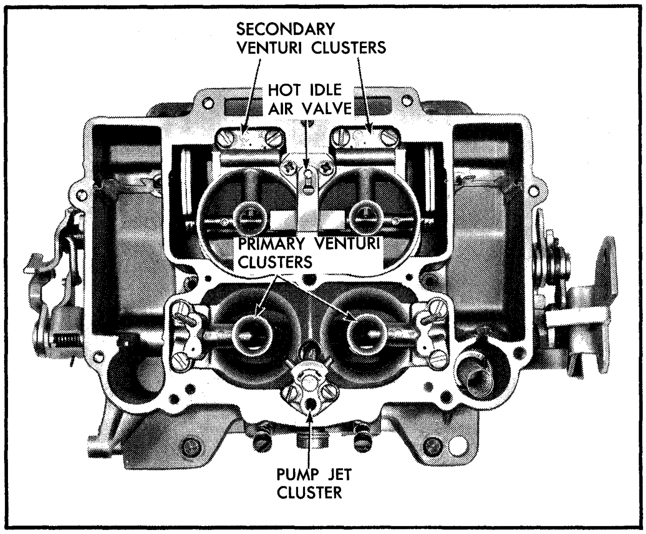



Fig. 6B-93 Venturi Clusters Installed

### ASSEMBLY OF AIR HORN

1. Slide choke shaft into air horn.

2. Install air horn gasket.

3. Install float needle seat and gasket, float needle and float assembly on pump side of air horn.

4. Install float needle seat and gasket, float needle, and float assembly on choke side of air horn.

5. Adjust float:

### A. ADJUST FLOAT ALIGNMENT

1. Sight down the side of the float shell to determine if the side of the float is parallel to the outer edge of the air horn casting. Adjust by bending float lever by applying pressure to the end of the float shell with the fingers while supporting the float lever with the thumb.

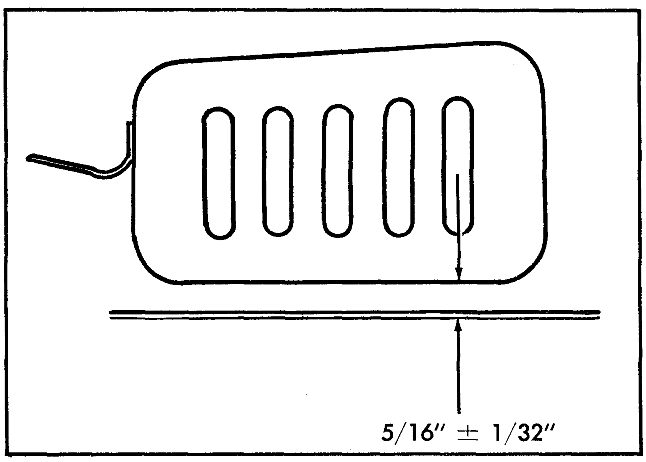



Fig. 6B-94 Float Level Check

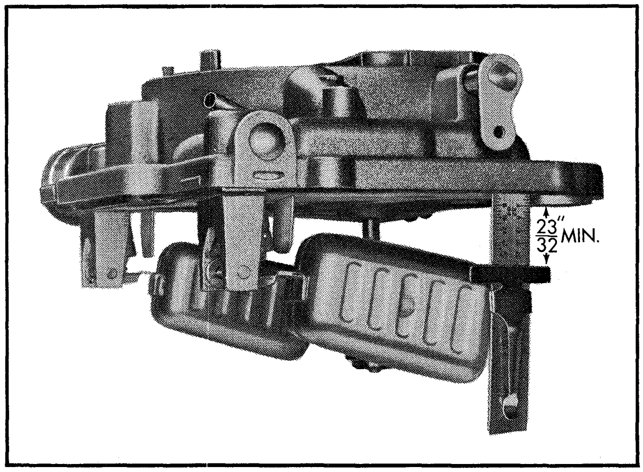



Fig. 6B-95 Checking Float Drop

*CAUTION: To avoid damaging the float, apply only enough pressure to bend float lever.*

2. After aligning float remove as much clearance as possible between arms of float lever and lugs on air horn by bending the float lever. Arms of float lever should be parallel to the inner surfaces of lugs on air horn as possible. Floats must operate freely without excess clearance on hinge pin.

### B. ADJUST FLOAT LEVEL (Fig. 6B-94)

With air horn inverted, gasket in place and needle seated, there should be 5/16" ± 1/32" clearance between float at point below first indention on side of float from toe end and air horn gasket. Fig. 6B-94 illustrates point where 5/16" ± 1/32" dimension should be checked. Bend float arm to adjust. Adjust both floats and recheck float alignment.

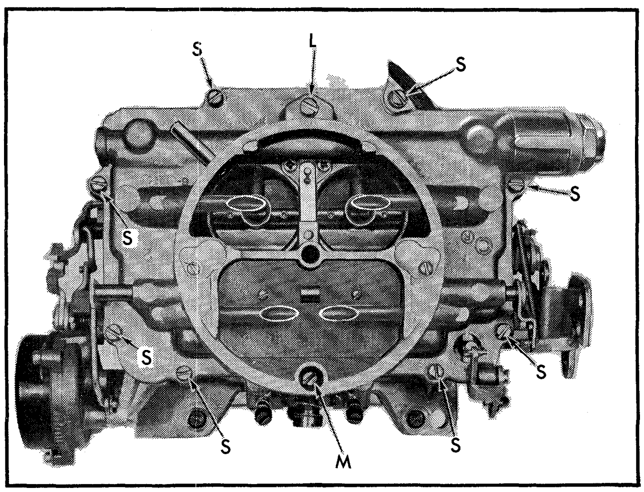



Fig. 6B-96 Location of Air Horn Attaching Screws S = Short M = Med. L = Long

### C. ADJUST FLOAT DROP (Fig. 6B-95)

With bowl cover held in upright position and measuring from outer end of each float, the distance between top of floats and bowl cover gasket should be a minimum of 23/32" min. To adjust, bend stop tabs on float brackets.

*NOTE: Maximum float drop can be any amount which will retain needle for installation. Needle must not wedge at maximum drop.*

6. Insert pump plunger shaft through air horn and retain with pump link.

7. Install air horn attaching screws (Fig. 6B-96).

8. Install two step-up rod piston springs in their respective bores.

9. Install step-up rod and piston on pump side of carburetor.

10. Install step-up rod and piston on choke side of carburetor.

11. Install two step-up piston cover plates and screws.

12. Install pump arm lever to air horn casting and connect pump link. Link must be installed as shown in Fig. 6B-97.

13. Insert lower end of pump connector rod in hole in throttle lever. Install upper end of rod in center hole in pump arm lever, retaining with clip.

14. Install choke valve with circle c in trademark visible with the choke valve closed.

15. Install choke connector rod between upper and lower choke lever.

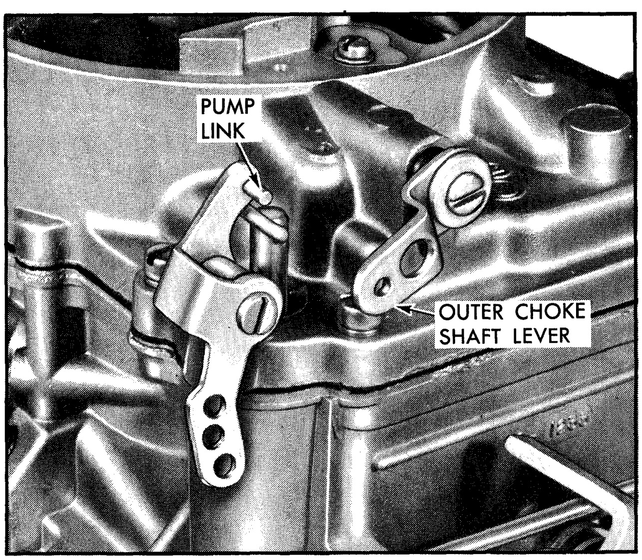



Fig. 6B-97 Pump Link Installed

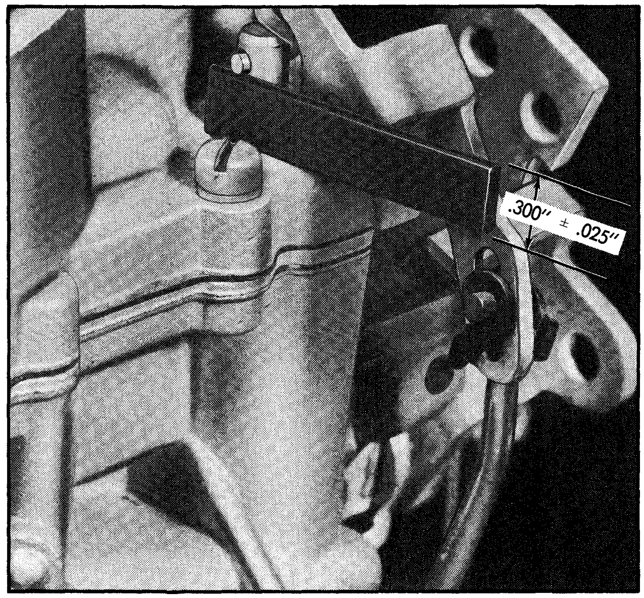



Fig. 6B-98 Checking Pump Adjustment

16. Install choke shaft lever, washer, and screw on end of choke shaft (Fig. 6B-97).

17. Install fast idle connector rod between fast idle cam and inner choke shaft lever.

18. Install throttle connector rod, and washers.

19. Install inlet screen plug and gasket.

### ADJUST PUMP

1. Be sure choke is wide open so fast idle cam does not hold throttle valves open.

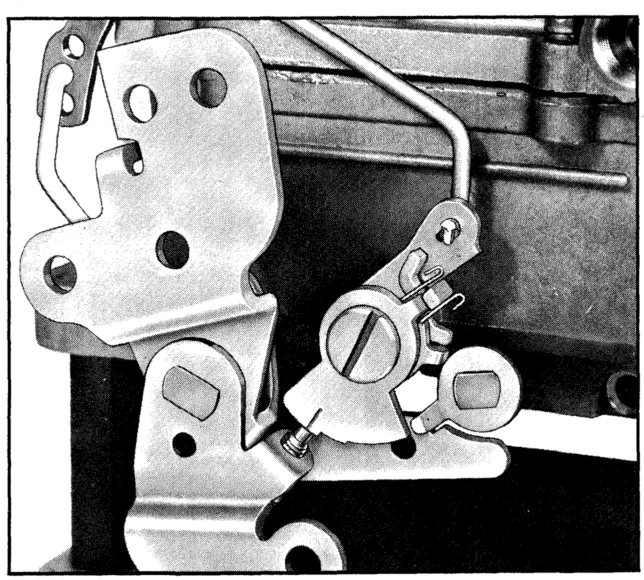


Fig. 6B-99 Checking Choke Shaft Lever

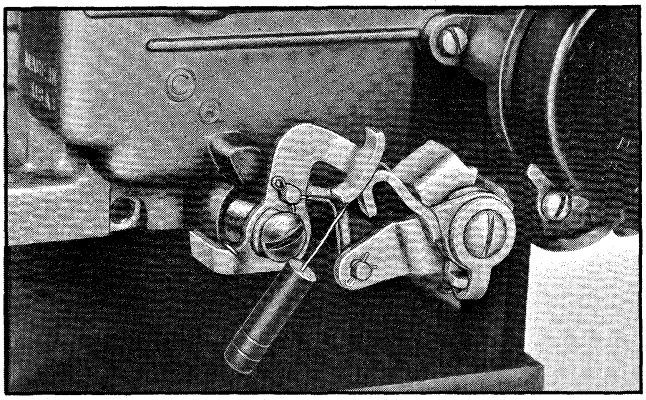


Fig. 6B-100 Checking Secondary Throttle Lever Adjustment

2. The distance from the top of the bowl cover to bottom of "S" pump link should be .300-.325" (Fig. 6B-98). Adjust pump linkage so that all play is removed at closed throttle position and full throttle lever travel is still obtainable.

3. To adjust, bend throttle connector rod at lower angle.

### ADJUST CHOKE PISTON LEVER

1. Remove three choke coil housing screws and choke coil housing and thermostatic coil.

2. Remove coil housing gasket and baffle plate.

3. Completely close choke valve.

4. Choke piston should be flush to 1/64" below outer lip of cylinder.

5. To adjust, bend choke connector rod.

### ADJUST CHOKE SHAFT LEVER

With choke valve fully closed and choke level and arm in contact, bend choke connector rod to align cam index mark on fast idle cam with fast idle screw (Fig. 6B-99).

### ADJUST SECONDARY THROTTLE LEVER

1. Open fully both sets of throttle valves. (In this position the stop lugs on primary and secondary throttle levers should contact the boss on the flange.)

2. To adjust, bend secondary throttle operation rod at angle.

*NOTE: Primary throttle valves will be a few degrees past vertical and secondary throttle valve will be a few degrees from vertical at wide open throttle.*

3. Now close primary and secondary throttle valves.

4. There should be .020" clearance between positive closing shoes on primary and secondary throttle levers (Fig. 6B-100) at their closest position.

5. To adjust, bend shoe on primary lever.

### ADJUST SECONDARY THROTTLE LOCKOUT

1. Crack throttle valves and manually open and close the choke valve.

2. Tang on secondary throttle lever should freely engage in notch of lockout dog.

3. If necessary to adjust, bend tang on secondary throttle lever.

| Carburetor Model | Usage | Features |
|---|---|---|
| 3687SA | Automatic | Distributor vacuum and throttle return check vacuum taken from back of carburetor.<br><br>Spark port at left of idle mixture screws plugged. |
| 3686S | Synchromesh | Timed spark advance with spark port and no throttle return check. |

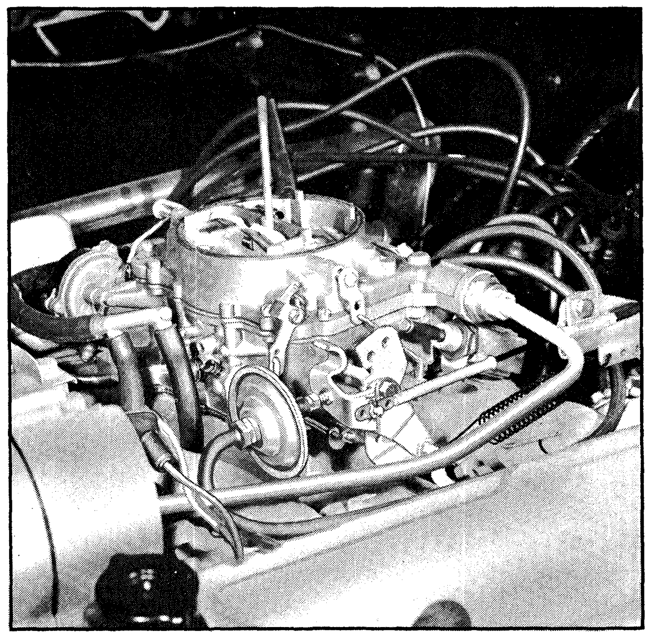


Fig. 6B-101 Throttle Return Hook-up With Automatic Transmission

# CARBURETOR—GENERAL

## TROUBLE DIAGNOSIS AND TESTING

When carburetor troubles are encountered they can usually be corrected by making the adjustments outlined under ADJUSTMENTS ON CAR. The following list of common troubles and their causes will frequently save considerable time in locating the cause of the difficulty.

*NOTE: Before any work is performed on the carburetor, make sure trouble is not due to poor compression, or in the ignition system due to improper timing, defective spark plugs, burned ignition points, etc. Always diagnose performance trouble by using the Pontiac Tune-N-Test Guide before adjusting or repairing the carburetor.*

When the cause of trouble is not located by the Tune-N-Test, check for trouble in the carburetor system as follows:

### POOR FUEL ECONOMY

*NOTE: Before any attempt is made to improve fuel economy the actual gasoline mileage should be determined using a tenth of a gallon tester. If the mileage obtained during this test compares favorably with that found on other normal cars, the poor mileage must be attributed to the driving conditions or driving habits of the owner. Also consider factors such as dragging brakes, soft tires, improper tire size, and improper speedometer driven gear.*

1. Check automatic choke to see that it operates properly and that it is correctly indexed.

2. Inspect manifold heat valve to see that it operates freely and thermostat is installed properly.

3. Check for leaks in fuel line fittings, at fuel tank, or at fuel pump bowl.

4. Check for dirty or restricted air cleaner.

5. Test for high fuel pump pressure.

6. Disassemble carburetor and check for evidence of vacuum leaks.

7. Check float level.

### SURGING CONDITION WITH HOT ENGINE

1. Lean carburetor adjustment. Check idle mixture setting.

2. Check fuel pump pressure and output.

3. Check needle and seat on leak down tester.

4. Check float adjustment.

5. Check for dirty or obstructed jets or fuel passages.

6. Check for loose cluster or jets.

### FLAT SPOT OR POOR ACCELERATION

1. Check manifold heat control valve thermostat for correct operation.

2. Check accelerator pump output visually to see if operating.

3. Check accelerator pump adjustment.

4. Check accelerator pump inlet and outlet valves for leakage.

5. Check for seating of accelerator pump plunger vent ball.

6. Check accelerator pump passages for dirt or obstructions.

### ROUGH IDLE

1. Check speed and mixture adjustment.

2. Check mixture screws for wear or burrs.

3. Check for manifold gasket leaks.

4. Check vacuum and choke heat connection.

5. Check operation and setting of choke system.

6. Check idle passage and throttle bore for carbon and dirt.

7. Check float adjustment.

**SERVICE SPECIFICATIONS**

| Carburetor Model | Float Level | Float Drop | Idle Vent | Vacuum Break | Choke Rod | Unloader | Stat Setting | Pump Rod | Secondary Throttle Lever |
|---|---|---|---|---|---|---|---|---|---|
| BV | | | | | | | | | |
| 7024164 | 1-9/32" ± 1/32" | 1-3/4" Min. | .040" ± .010" | .142" ± .017" | .060" ± .015" | .230" .030" | | | |
| 7024166 | 1-9/32" ± 1/32" | 1-3/4" Min. | .040" ± .010" | .142" ± .017" | .060" ± .015" | .230" ± .030" | | | |
| 2GC | | | | | | | | | |
| 7023071 | 5/8" ± 1/16" | 1-3/4" Min. | 1-17/64" ± 1/64" | | .080" ± .010" | .160" ± .030" | Index | 1-21/64" ± 1/32" | |
| 7024062 | 5/8" ± 1/16" | 1-3/4" Min. | 1-17/64" ± 1/64" | | .070" ± .010" | .160" ± .030" | Index | 1-21/64" ± 1/32" | |
| AFB | | | | | | | | | |
| 7023071 | 5-16" ± 1/32" | 23/32" Min. | | | Choke Piston Flush To 1/64 Below Cylinder Outer Lip | .150" ± .030" | One Notch Rich | In Center Hole | .020" ± .010" |
| 7024062 | 5-16" ± 1/32" | 23/32" Min. | | | | .150" ± .030" | | .300" .030" | |

8. Check for secondary throttle sticking (4 barrel).

9. Check engine compression.

10. Check spark plug gaps.

### IMPROPER HIGH SPEED PERFORMANCE

1. Check spark plugs for correct gap and condition.

2. Check distributor points.

3. Check fuel pump output and pressure.

4. Check filter for restriction or plugging.

5. Check carburetor for evidence of internal vacuum leaks.

6. Check float level adjustment.

7. Check high speed passages for dirt or obstruction.

### FLOODING OR LEAKING

1. Check for foreign material in needle and seat area.

2. Check needle and seat on leak down tester.

3. Check float adjustment (make sure float is not binding or rubbing).

4. Check for leaking or collapsed float.

5. Check for cracked bowl or loose passage plugs.

# FUEL PUMP

## 6 CYL. AND V-8

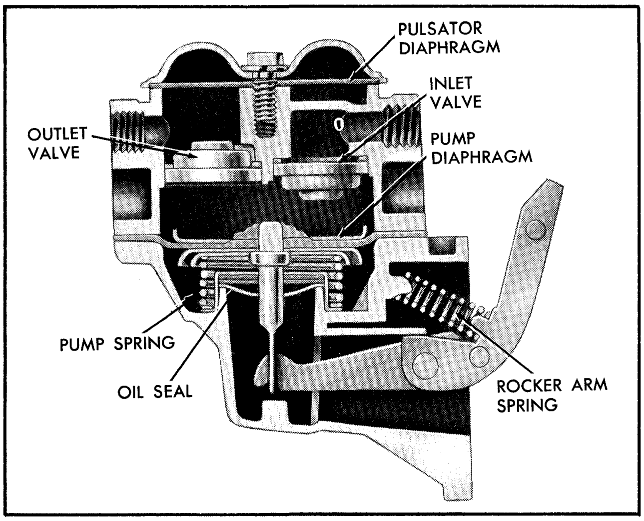



Fig. 6B-102 Schematic View of Fuel Pump 6 Cyl.

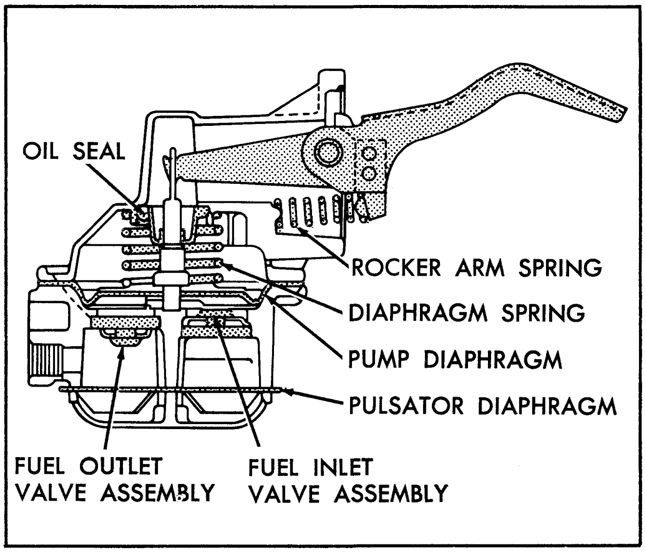



Fig. 6B-103 Schematic View of Fuel Pump V-8

### DESCRIPTION (Figs. 6B-102 & 6B-103)

The rocker arm spring keeps the rocker arm in constant contact with the eccentric (behind the third lobe of the camshaft, 6 cyl.; bolted to the front of the camshaft, V-8) so that the rocker arm moves up and down as the camshaft rotates. As the 6 cyl. pump rocker arm is moved upward and V-8 pump rocker arm downward, it bears against a link which is also pivoted on the rocker arm pin. The link is hooked to the diaphragm pull rod so that the diaphragm is moved away from the fuel chamber and the diaphragm spring is compressed. The enlarging fuel chamber moves gasoline from the tank through the tubing inlet valve and into the space below the diaphragm.

As the rotating eccentric permits the rocker arm to move away from contact with the link, the compressed diaphragm spring is free to move the diaphragm upward, 6 cyl.; downward V-8 to expel the fuel through the outlet valve to the carburetor bowl.

Because the diaphragm is moved upward, 6 cyl.; downward V-8 only by the diaphragm spring, the pump delivers fuel to the carburetor only when the pressure in the outlet line is less than the pressure maintained by the diaphragm spring. Fuel is delivered to the carburetor only when the needle valve is open. When the needle valve is closed by pressure of fuel on the float, the pump builds up pressure in the space below the diaphragm and in the outlet tube until the diaphragm spring is compressed. The diaphragm then remains stationary until more fuel is required.

### OVERHAUL AND ADJUSTMENT

*(Fig. 6B-104)*

#### *DISASSEMBLY*

1. Scratch locating marks on fuel cover and pump body so that inlets and outlets will be properly located when pump is reassembled.

2. Place pump in soft jawed vice.

3. Remove bolt and washer from pulsator cover plate. Remove pulsator cover and diaphragm from pump cover.

4. Remove pump cover screws except any two that are diametrically opposite.

5. Press down firmly on the cover to hold the diaphragm spring compressed and remove the remaining two screws. Release the cover slowly and remove cover assembly.

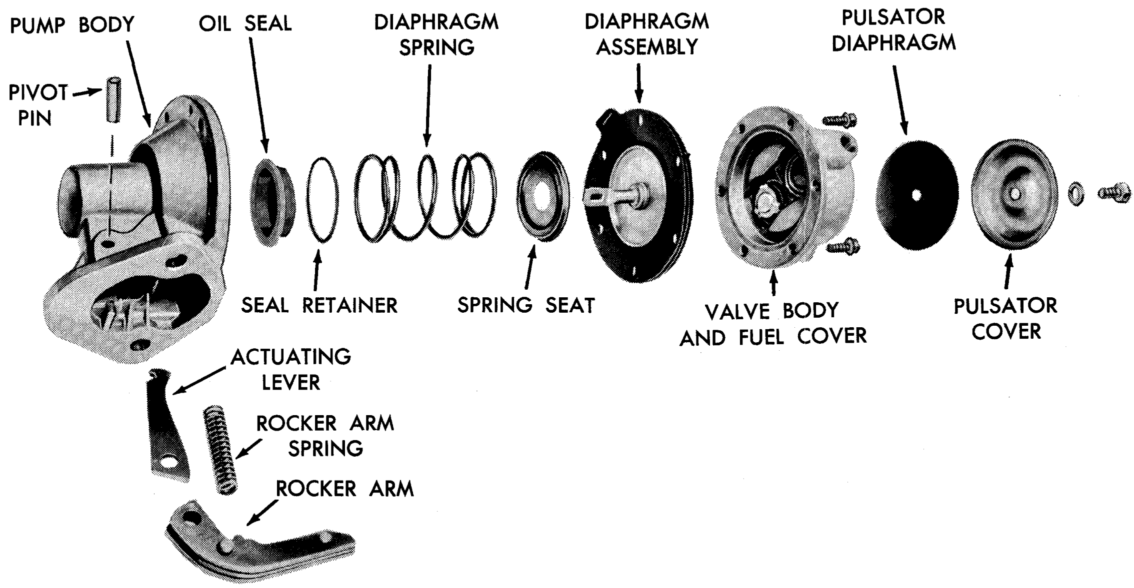



Fig. 6B-104 Typical Fuel Pump - Exploded View

6. Drive out rocker arm pin with a tapered drift after removing sufficient staked metal from the pin. Be sure to leave sufficient metal for restaking.

7. Remove rocker arm, rocker arm spring and link.

8. Remove diaphragm assembly and diaphragm spring.

9. Using a small chisel, round file or small grinding wheel, remove metal from around oil seal retainer which was displaced by staking during assembly. Pull out seal and seal retainer using a hooked shaped tool.

*CAUTION: Use care not to damage oil seal seats.*

10. Remove metal displaced by staking around inlet and outlet valves. Pry valves and cages out with screwdriver blade. Lift out gaskets.

## CLEANING AND INSPECTION

1. Clean and rinse all metal parts in solvent. Blow out all passages with compressed air.

2. Inspect pump body, cover and pulsator cover for cracks, breakage or distorted flanges. Examine all screw holes for stripped or crossed threads. If any of these three parts are damaged, the pump should be replaced.

3. Inspect rocker arm, link and pin for wear.

## ASSEMBLY

1. Install new oil seal and retainer in pump body and press firmly in place.

2. Stake die cast lip in four places to retain seals.

3. Position link and rocker arm in pump body with hook of link pointing toward top of pump.

4. Align holes and drive rocker arm pin through rocker arm.

5. Install small washer on rocker arm pin and restake pin securely.

6. Install inlet and outlet gaskets and valves in pump cover. Press valve and cage assembly against gasket and stake in position.

7. Soak pump diaphragm in clean kerosene. Fuel oil may be used, but do not use shellac or sealing compound.

8. Place pump body in soft jawed vise.

9. Place diaphragm on bench with pull rod pointing up. Position spring over pull rod.

10. Pick up diaphragm and spring as an assembly and push pull rod through oil seal into body. Be sure

diaphragm spring is seated in body. Have flat of pull rod parallel to flat of link with the diaphragm flush with the body. With palm of hand, turn the diaphragm 90°, or until flat of pull rod is perpendicular to pump link. This motion should engage the pull rod "eye" with the link hook. If not, repeat this procedure until the connection is made.

*CAUTION: Extreme care should be used to avoid damaging oil seal.*

11. Position rocker arm spring between projection on rocker arm and conical projection on body.

12. Install pump cover on body making sure that scratch marks on cover and body line up. Push on rocker arm until diaphragm is flat across body flange. Install cover screws and lockwashers loosely until screws just engage lockwashers. Push rocker arm through its full stroke and hold in that position while tightening cover screws securely.

*NOTE: Diaphragm must be flexed before tightening cover screw or pump will deliver too much pressure.*

13. Place new pulsator diaphragm on pump body. Install pulsator cover with bolt and lockwasher.

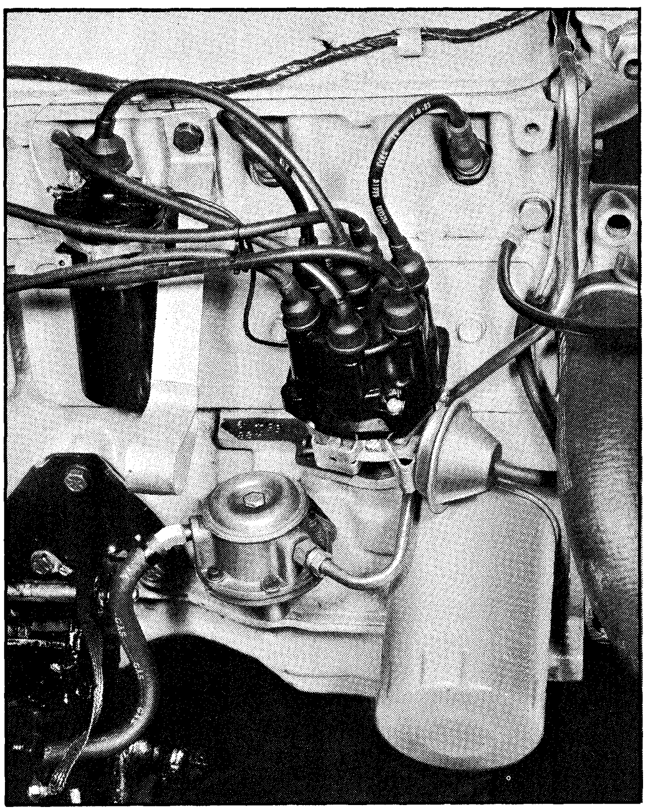


Fig. 6B-105 Fuel Pump Installed 6 Cyl.

## TROUBLE DIAGNOSIS AND TESTING

Always check fuel pump while it is mounted on the engine (Figs. 6B-105, 106) and be sure there is gasoline in the tank.

The line from the tank to the pump is the suction side of the system. The line from the pump to the carburetor is the pressure side of the system. A leak on the pressure side of system would be visible because of dripping fuel. A leak on the suction side would not be apparent except for its effect of reducing the volume of fuel on the pressure side.

1. Tighten any loose line connections and look for bends or kinks in lines which could reduce the flow of fuel.

2. Tighten diaphragm flange screws.

3. Disconnect fuel pipe at carburetor. Disconnect distributor to coil primary wire so that the engine can be cranked without firing. Place suitable container at end of pipe and crank engine a few revolutions. If little or no gasoline flows from open end of pipe, then fuel pipe is clogged or pump is inoperative. Before removing pump, disconnect fuel pipe at inlet of pump and at gas tank outlet pipe and blow through them with an air hose to make sure they are clear. Reconnect pipes to pump and retest while cranking engine.

4. If fuel flows from pump in good volume from pipe at carburetor, check fuel delivery pressure to be certain that fuel pump is operating within specified limits as follows:

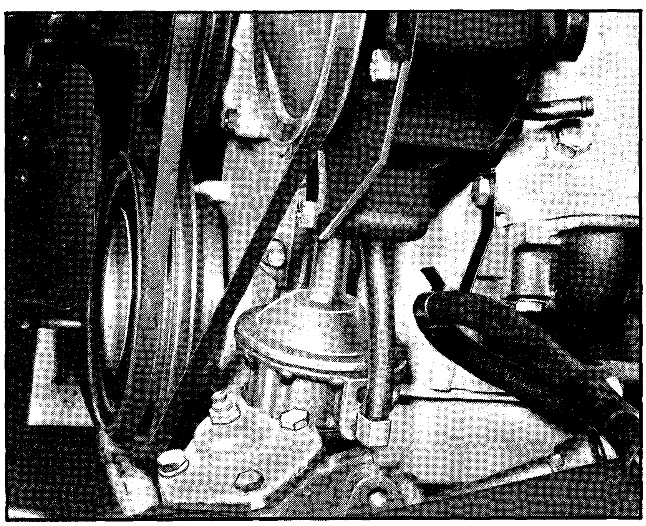


Fig. 6B-106 Fuel Pump Installed V-8

a. Attach a fuel pump pressure test gauge to disconnected end of pump to carburetor pipe.

b. Run engine at approximately 1000 rpm on gasoline in carburetor bowl and note reading on pressure gauge.

c. If pump is operating properly, the pressure will be between 3-1/2 to 4-1/2 psi at 1000 rpms on 6 cyl.; 5-1/4 to 6-3/4 at 1000 rpm on V-8. If pressure is too low or too high, or varies materially at different speeds, the pump should be removed for repair.

# ENGINE TUNE-UP

## CONTENTS OF THIS SECTION



## GENERAL DESCRIPTION

A minor tune and test consists of testing battery, cleaning, regapping or replacing, if required, spark plugs and distributor points; adjusting distributor dwell angle, ignition timing, carburetor idle mixture, hot idle speed and fast idle speed, checking manifold heat control valve and check automatic choke operation and setting.

The complete or major tune and test procedure consists of these basic items plus other ignition, compression, electrical and carburetor checks, and a final road test to ensure continued trouble free operation.

## BASIC PROCEDURE

### *CONNECT TUNE-UP EQUIPMENT*

Follow manufacturer recommendations for the use of testing equipment. Fig. 6C-1 shows a basic schematic for instrumentation which will apply to many types of test equipment and may be used as a rough

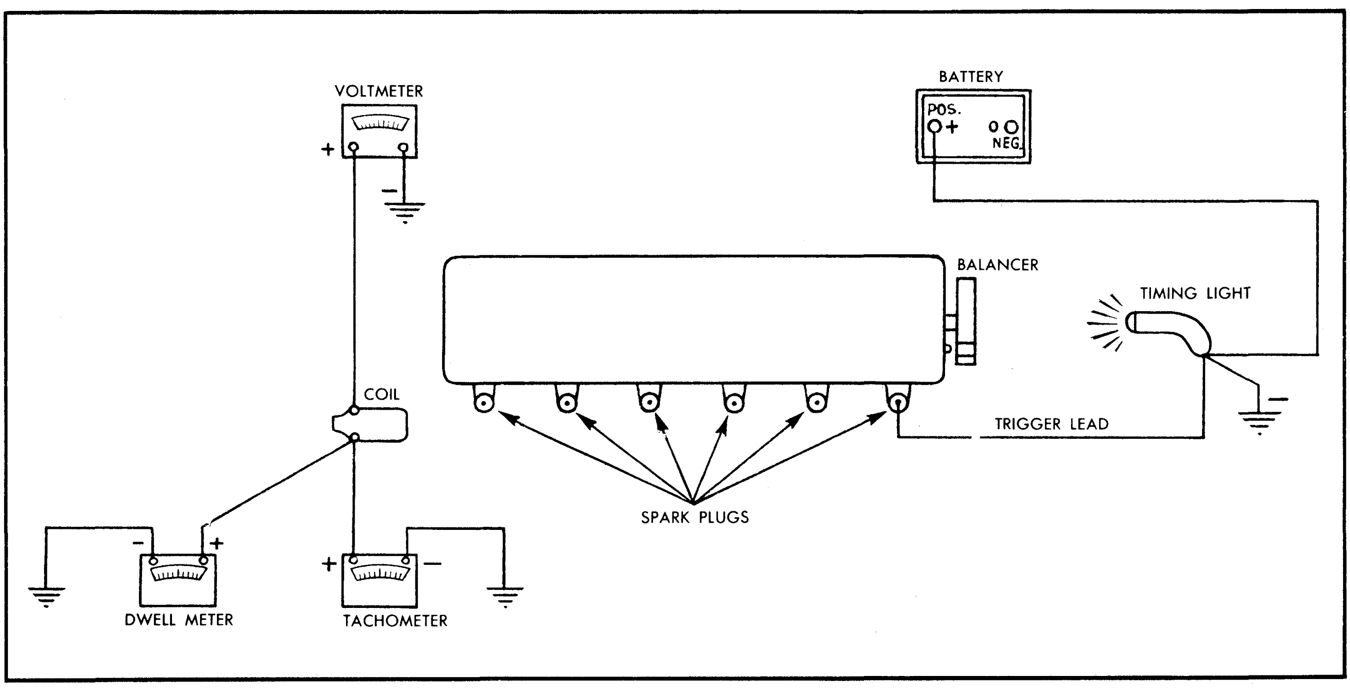



Fig. 6C-1 Basic Instrumentation for Tune-up

guide if equipment manufacturers instructions are not available.

Connections shown in Fig. 6C-1 are made as follows:

1. Voltmeter
   a. Positive lead to resistor side of coil.
   b. Negative lead to ground.
2. Timing Light
   a. Positive lead to positive battery terminal.
   b. Negative lead to ground.
   c. Trigger lead to number 1 spark plug.
3. Tachometer
   a. Positive lead to distributor side of coil.
   b. Negative lead to ground.
4. Dwell Meter
   a. Positive lead to distributor side of coil.
   b. Negative lead to ground.

### TEST BATTERY VOLTAGE BEFORE AND WHILE CRANKING ENGINE

*NOTE: Disconnect distributor to coil primary wire during this test to prevent engine from firing.*

Terminal voltage while cranking must not be less than 9.0 volts. Engine cranking speed (approximately 180 rpm) should also be observed during this check to see that it is satisfactory. If cranking speed is low, check starting circuit to locate cause of low speed. If battery voltage is low while cranking, further tests of battery and/or starting motor circuit should be made to locate trouble.

To insure proper electrical operation, the battery should be in good condition and be adequately charged. Check cell to cell voltage as outlined in section 11 and recharge or replace as necessary.

### REMOVE AND RECONDITION SPARK PLUGS

See that correct spark plugs are used. Spark plug insulators should be thoroughly cleaned to prevent possible flash-over. Thoroughly clean lower insulator and cavity by sand blasting. File both electrodes flat (rounded surfaces increase voltage required to fire plugs) and set gap to .035". When plugs are reinstalled, use new gaskets and tighten plugs to 25 lb. ft. torque.

### CLEAN AND ADJUST DISTRIBUTOR POINTS

Remove distributor cap and inspect points for excessive burning or pitting. Replace points if necessary. Use a point file to clean contact area and remove scale from points. Filing is for cleaning purposes only. Do not attempt to remove all roughness. Apply a trace of bearing lubricant to the breaker cam. Adjust distributor dwell angle to 31-34 degrees on six cylinder models and 26-32 degrees on eight cylinder models.

### SET IGNITION TIMING

With distributor vacuum line disconnected and car operating at normal idle speed or below, set ignition timing. Follow procedure outlined in Section 11 of this manual. Correct settings are 4° BTDC for 6 cyl. engines, 6° BTDC for V-8 engines.

### ADJUST HOT IDLE SPEED AND MIXTURE

Following adjustment procedure outlined in section 6B, adjust carburetor idle speed and mixture to the following specifications:

| | RPM 6 Cyl. | RPM 8 Cyl. |
|---|---|---|
| S.M. Transmission | 580-600 | 580-600 |
| S.M. Transmission with Air Conditioning* | 580-600 | 640-660 |
| Auto. Transmission with "Drive" | 480-500 | 480-500 |
| Auto. Transmission with Air Conditioning* | 480-500 | 540-560 |

*IDLE SPEED-UP DEVICE On automatic transmission and synchromesh transmission 6-cylinder engines with air conditioning only. Set hot idle speed and mixture as above and on automatic transmissions leave transmission in drive. Turn air conditioning on for maximum cooling and adjust diaphragm plunger screw to obtain the following engine speeds.

| | |
|---|---|
| A. Automatic transmission | 480-500 |
| B. Synchromesh transmission | 580-600 |

*CAUTION: The idle speed-up diaphragm plunger must be restrained from turning while adjusting plunger screw to prevent injury to diaphragm.*

### ADJUST FAST IDLE SPEED

Following procedures outlined in Section 6-B, adjust fast idle speed to the following:

| | |
|---|---|
| V-8 (4 Bbl.) | 2500 RPM |

### ANTI-STALL DIAPHRAGM SETTING

Before attempting to set the anti-stall diaphragm, the hot idle speed must be adjusted on 1 and 2 Bbl. carburetors, and the hot idle speed and fast idle speed both must be set on the 4 Bbl. carburetor to specifications.

With the engine running, place transmission in neutral, disconnect the vacuum hose from throttle return check and plug end of vacuum hose. Adjust the contact screw of the throttle return check to obtain 1030-1080 RPM. After adjustment, unplug vacuum hose and reconnect to throttle return check.

*CAUTION: The anti-stall diaphragm plunger must be restrained from turning while adjusting plunger screw to prevent injury to the diaphragm.*

### SEE THAT EXHAUST MANIFOLD HEAT VALVE OPERATES FREELY

Manifold heat valve must operate freely. If stuck open, it can cause sluggish operation of the engine, especially during warm-up. If stuck closed, engine performance when hot will be unsatisfactory.

### CHECK CARBURETOR CHOKE AND UNLOADER OPERATION AND ADJUSTMENT

The specified choke setting provides ideal choke operation in all climates. No seasonal changes are necessary.

Settings are listed in Section 6-B.

The choke should just close at 75°F. when set at index. In rare cases, it may be necessary to change slightly (never more than two notches) from the standard setting to properly calibrate the choke. Excess carbon in choke housing may indicate a leaking choke heat tube.

Choke linkage and fast idle cam must operate freely. Do not lubricate linkage since this will collect dust and cause sticking.

Check unloader action. Inoperative unloader can cause complaints of difficult hot starting. Adjust as outlined in Section 6-B.

## ADDITIONAL PROCEDURES

For diagnosis purposes, it is sometimes necessary to proceed further than the basic tune-up procedure. The following steps plus a road test are included in a complete or major tune and test procedure.

### CLEAN TOP OF BATTERY, TIGHTEN TERMINALS AND HOLD DOWN CLAMP

*CAUTION: Never reverse battery leads, even for an instant, as reverse polarity current flow will damage diodes in the alternator.*

Clean top of battery and terminals with a solution of baking soda and water. Rinse off and dry with compressed air. The top of the battery must be clean to prevent current leakage between the terminals and from the positive terminal to the hold down clamp.

In addition to current leakage, prolonged accumulation of acid and dirt on top battery may cause blistering of the material covering the connector straps and corrosion of the straps. After tightening terminals, coat them with petrolatum to protect them from corrosion.

*CAUTION: Excessive tightening of the hold down clamp can crack the battery case.*

### TEST COMPRESSION PRESSURE OF EACH CYLINDER

*NOTE: If this test is to be performed, it should be done when plugs are removed for service during the basic tune-up procedure.*

Unless checking for worn rings or for the cause of low speed miss, compression check should not be necessary.

Test compression with engine warm, all spark plugs removed and throttle and choke open. No cylinder should be less than 80% of the highest cylinder (see examples). Excessive variation between cylinders, accompanied by low speed missing of the cylinder or cylinders which are low, usually indicates a valve not properly seating or a broken piston ring. Low pressures, even though uniform, may indicate worn rings. This may be accompanied by excessive oil consumption.

TEMPEST (6 Cyl.)

**Example 1**

| Cyl. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Press. | 129 | 127 | 130 | 121 | 116 | 102 |

80% of 130 (highest) is 104. Thus cylinder No. 6 is less than 80% of No. 3. This condition, accompanied by low speed missing, indicates a burned valve or broken piston ring.

**Example 2**

| Cyl. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Press. | 85 | 96 | 90 | 87 | 85 | 91 |

80% of 96 is 77. While all cylinders are well above 77, they are all excessively low. This indicates all poor valves or, if accompanied by oil consumption, worn rings or low crank speed.

If compression is subnormal, the tune-up will probably not be satisfactory.

TEMPEST (V-8)

**Example 1**

| Cyl. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Press. | 136 | 138 | 135 | 144 | 102 | 137 | 140 | 141 |

80% of 144 (highest) is 115. Thus cylinder No. 5 is less than 80% of No. 4. This condition, accompanied by low speed missing, indicates a burned valve or broken piston ring.

**Example 2**

| Cyl. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Press. | 85 | 91 | 90 | 87 | 96 | 93 | 87 | 89 |

80% of 96 is 77. While all cylinders are well above 77, they are all excessively low. This indicates all poor valves, or if accompanied by oil consumption, worn rings or low crank speed. If compression is subnormal, the tune-up will probably not be satisfactory.

### *CLEAN CARBURETOR AIR CLEANER AND CRANKCASE VENTILATOR AIR CLEANERS*

The entire air cleaner should be removed from the car for cleaning. The metal cover and shell of the air cleaner should be cleaned on the inside surfaces.

Remove filter element from standard carburetor air cleaner. Wash dirt from filter element and from crankcase ventilator inlet by plunging up and down several times in suitable solvent. Drain dry and re-oil.

The heavy duty air cleaner element should be washed in kerosene, squeezed dry and dipped in SAE 10W-30 oil. Squeeze dry again to remove excess oil. DO NOT WRING DRY.

### *CLEAN AND INSPECT HIGH TENSION WIRES, DISTRIBUTOR CAP AND ROTOR*

*NOTE: This operation is to be performed while checking distributor points during the basic tune-up procedure. Inspect distributor cap for cracks and flash over.*

External surfaces of all parts of the secondary system must be cleaned to reduce the possibility of voltage loss. All wires should be removed from the distributor cap and coil so that terminals can be inspected and cleaned. Burned or corroded terminals indicate that wires were not fully seated, causing arcing between the end of the wire and the terminal. When replacing wires in terminal, be sure they are fully seated before pushing rubber nipple down over tower. Check distributor rotor for damage.

### *TIGHTEN INTAKE MANIFOLD AND CARBURETOR ATTACHING NUTS*

Intake manifold attaching screws and nuts on engines should be tightened to proper torque. Carburetor attaching nuts should be tightened securely. Leaks at these areas can cause rough idle, surging, deceleration popping, or deceleration whistle.

### INSPECTION

Inspect for oil and/or coolant leaks. Check radiator hoses. Check and adjust engine fan and accessory drive belt tension. Clean steering wheel.

## ROAD TEST

### TEST PERFORMANCE OF CAR

Observe performance of engine at low speed, during acceleration, and at constant speed. Check for missing, stalling, surging, poor acceleration or flat spots on acceleration. If any irregularity is found, refer to the appropriate section of the manual for repair procedures.

### TEST OPERATION OF:

BRAKES - Pedal should not go closer than 2" from floor mat and car should not pull to either side.

PARKING BRAKE - Should hold the car without excessive movement of parking brake pedal.

AUTOMATIC TRANSMISSION - Observe shift at minimum, medium, and full throttle and test part throttle and forced downshift. Watch for slipping or unusual shift characteristics that may indicate need for adjustment.

STEERING GEAR - See that steering operates normally and that steering wheel does not have excessive play. Also observe for alignment of steering wheel, pull, wander, or other irregularity that might indicate need for front end alignment.

WINDSHIELD WIPER - Wiper operation should be tested with windshield wet in order to properly judge the action.

CLUTCH - See that clutch engages smoothly and that pedal has approximately 1" of free travel. "Hard" pedal or lack of pedal return may indicate need for linkage adjustment.

LIGHTS AND HORNS - Test operation and aim of headlights, operation of all lights and horn.

INSTRUMENTS - Observe operation of all instruments. Observe especially for possible abnormal readings which may indicate trouble.

ACCESSORIES - Test operation of radio, heater, defroster, cigar lighter, other accessories.

# ENGINE CLUTCH

CONTENTS OF THIS SECTION



## DESCRIPTION

A single plate, dry disc type clutch is used on all Tempest cars with synchromesh transmissions. The clutch assembly consists of the clutch driven plate assembly, the clutch cover and pressure plate assembly, and the clutch release mechanism.

The driven plate for all three Tempest clutches (standard and heavy duty for 6 cylinder and one for V-8) differ from each other in plate size and damper spring calibration. The six cylinder standard clutch driven plate is 9.12 in diameter, the six cylinder heavy duty is 10.00 in diameter and the V-8 is 10.40 in diameter. Grooves on both sides of the clutch plate lining prevent the sticking of the plate to the flywheel and pressure plate due to vacuum between the members.

The driven plate incorporates a damper assembly in the hub to prevent the transmitting of torsional vibrations from engine to transmission.

The pressure plate for all three clutch assemblies is of the disc spring type. Fig. 6D-1. There is an overcenter effect inherent in the action of the disc spring itself. This eliminates the need for an overcenter spring.

Pressure plate spring pressure forces the driven plate against the flywheel, thereby coupling the engine to the transmission.

The clutch release mechanism consists of a ball thrust bearing, appropriate levers and linkage to manually control the action of the bearing. The ball thrust bearing is piloted on a tubular support. When pressure is applied to the clutch pedal to release the clutch, the clutch fork pivots on its ball socket. The inner end then pushes the release bearing forward so that it presses against the inner ends of the clutch release levers, releasing the clutch (Fig. 6D-1). Pedal effort is transmitted by the pedal to the lever assembly and thence through the clutch fork.

## PERIODIC SERVICE

See "General Lubrication" Section.

## CLUTCH PEDAL ADJUSTMENT

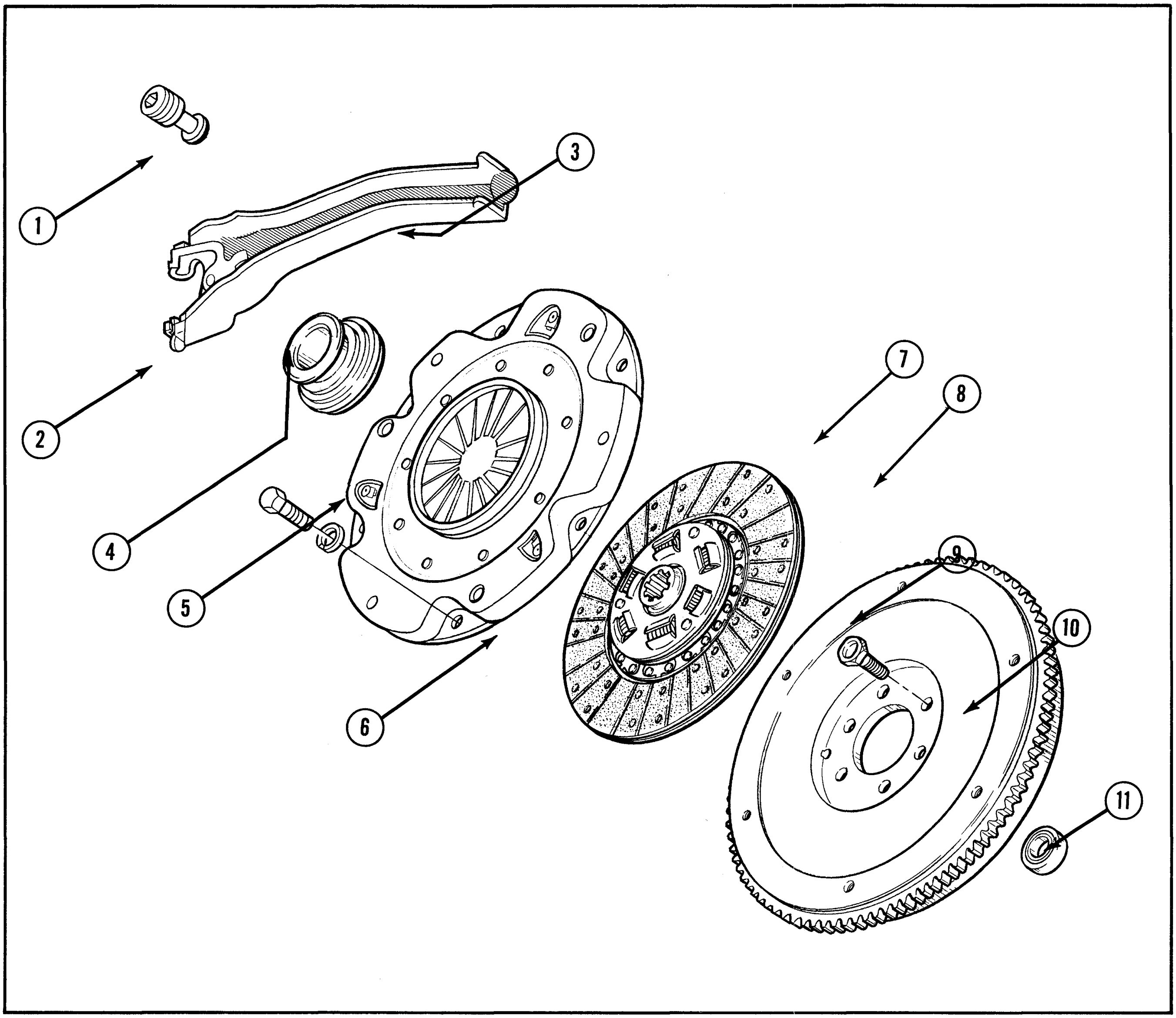
Wear on the clutch parts necessitates occasional lash adjustment. No other adjustment is made. Lash adjustment should be made as follows:

1. Unhook the linkage return spring.

2. With clutch pedal against stop: loosen lock nut sufficiently to allow the adjusting rod to be turned out of swival (8 cyl.) or push rod (6 cyl.) and rearward against the clutch fork until the release bearing contacts pressure plate fingers lightly.

3. Rotate push rod into swival or push rod 3-1/2 turns and tighten lock nut 8-12 lb. ft. torque.

4. Install return spring. Approximately 1" of lash should be at pedal.




1. Crankshaft Clutch Pilot Bearing
2. Flywheel Ring Gear
3. Engine Flywheel
4. Flywheel to Crankshaft Bolt
5. Clutch Driven Plate (with facings)
6. Clutch Cover and Pressure Plate Assembly
7. Clutch Cover to Flywheel Bolt Washer
8. Clutch Cover to Flywheel Bolt
9. Clutch Release Bearing
10. Clutch Release Fork
11. Clutch Release Fork Ball

Fig. 6D-1 Clutch and Flywheel Assy.—Exploded View

## SERVICES & REPAIRS

### *CLUTCH CONTROL LINKAGE*

REMOVE

1. Remove return spring.

2. Disconnect retainer from each end of intermediate rod.

3. Loosen nut and lockwasher from ball stud at frame and remove countershaft assembly.

REPLACE

1. Reverse removal steps. Tighten ball stud nuts 25-35 lb. ft. torque.

2. Adjust lash. See clutch adjustment under periodic service.

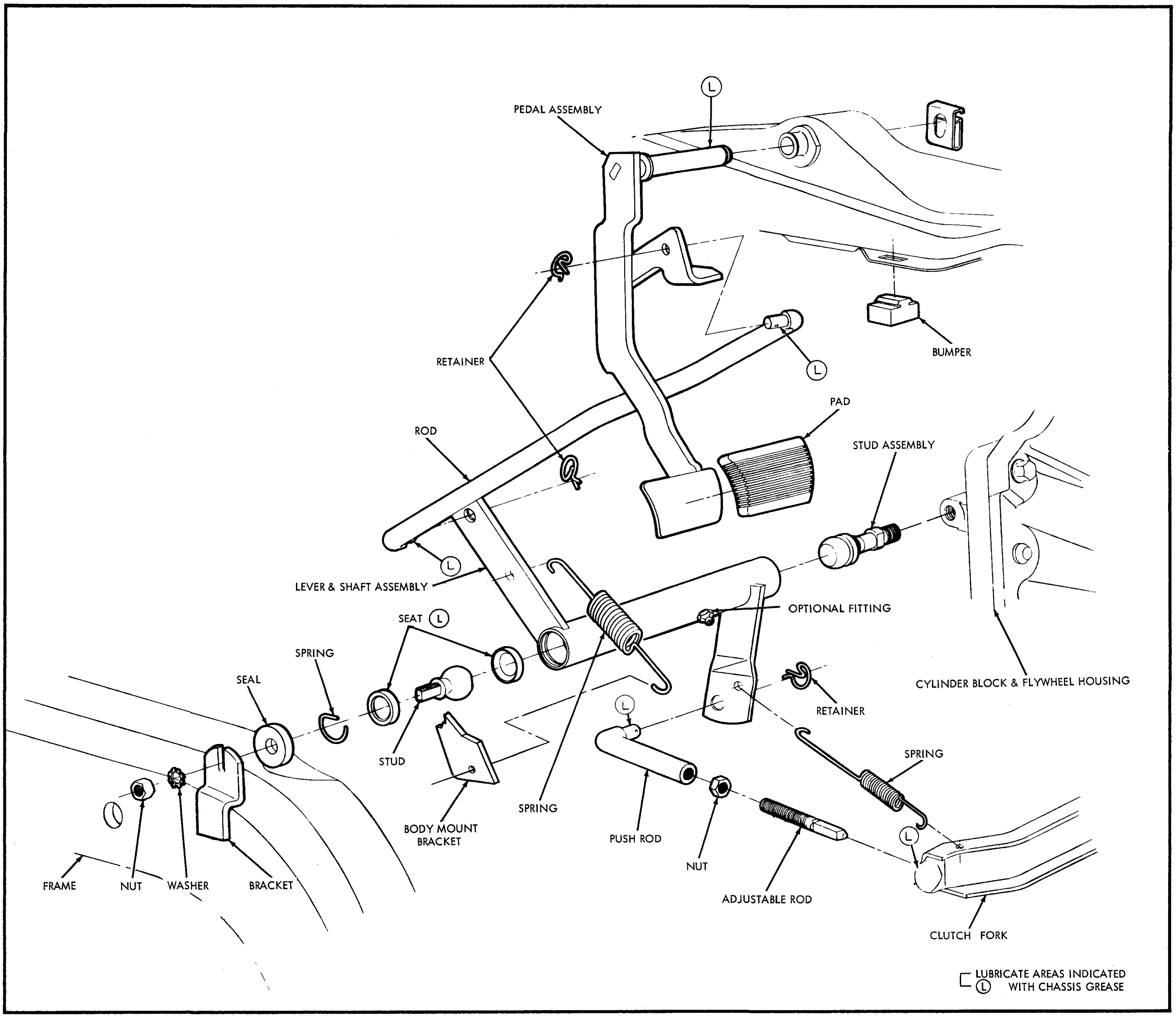



Fig. 6D-2 Clutch Control Linkage - 6 Cyl.

## CLUTCH—REMOVE AND REPLACE

REMOVE

1. Disconnect battery to starter lead at battery.

2. Remove propeller shaft and transmission. See TRANSMISSION SECTION. Exercise care to avoid damaging transmission front retainer (release bearing support) when transmission is pulled back to free main drive (clutch) gear from flywheel housing.

3. Remove release bearing through rear opening in clutch housing. Do not place bearing in any degreasing solvent, etc.

4. Remove return spring.

5. Remove starter.

6. Remove front flywheel housing shield.

7. Remove flywheel housing bolts and pull housing off of dowels.

8. Remove flywheel housing.

9. Mark clutch pressure plate cover and flywheel to insure reassembly in the same position as balanced at factory.

10. Loosen bolts holding clutch cover to flywheel one turn at a time until tension is relieved.

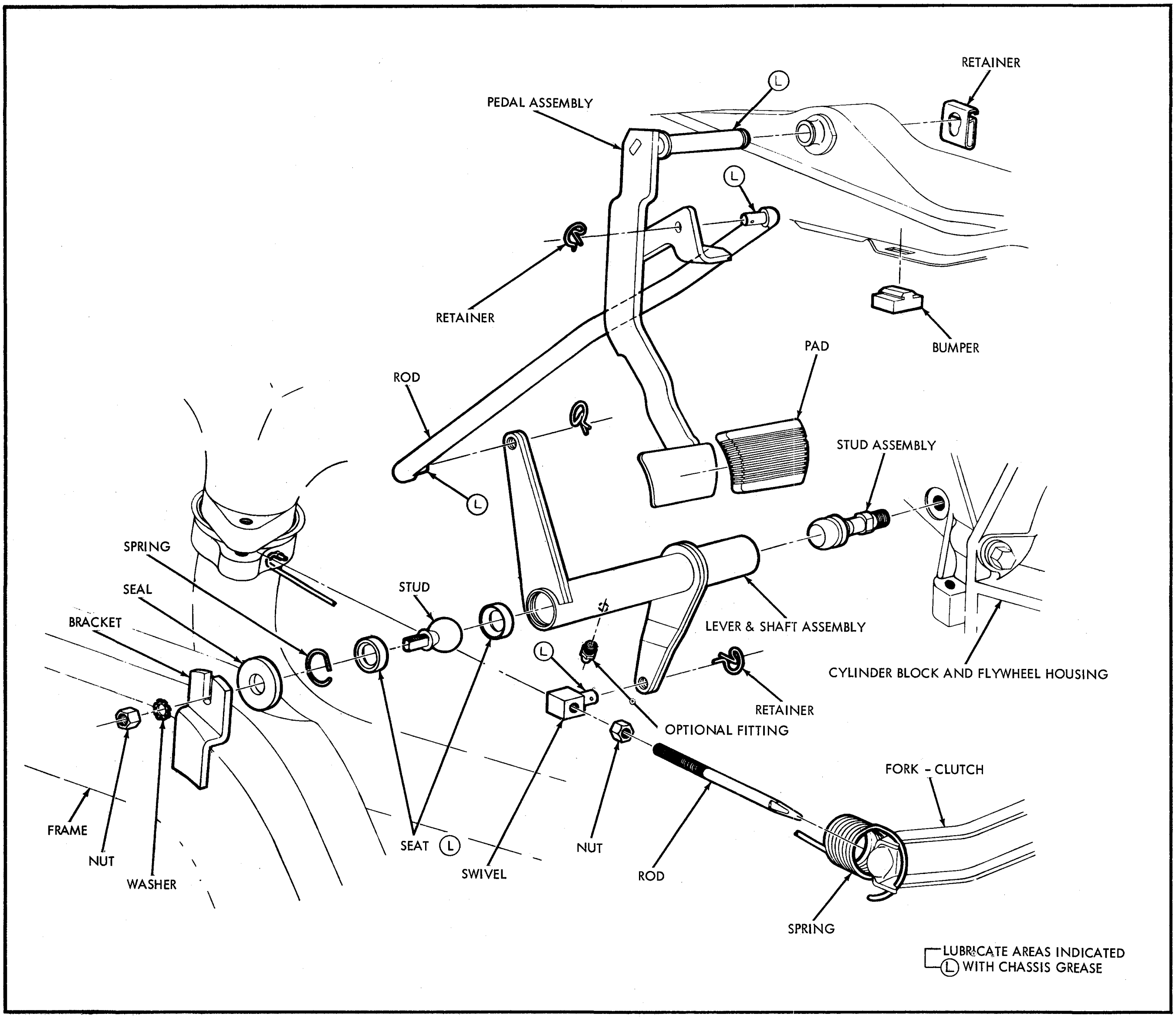



Fig. 6D-3 Clutch Control Linkage - 8 Cyl.

11. Remove all but top bolt and move clutch assembly away from flywheel at bottom so as to permit removal of clutch driven plate.

12. Remove remaining bolt to remove clutch cover plate assembly.

## INSPECT

1. Inspect clutch driven plate for broken or distorted torsion springs, worn or loose facings, oil on facings, and damaged spline which could cause binding. If any of the above defects are present, replace driven plate with new assembly.

*NOTE: Servicing of clutch driven plate must be by replacement of plate assembly only.*

2. Inspect pressure plate and cover assembly to see that it is free of oil and grease. Check pressure plate for scores or cracked surface.

*NOTE: Servicing of clutch driven plate or pressure plate and cover assembly must be made by replacement of assemblies only.*

3. Examine transmission retainer carefully to be certain there are no burrs on outer surface which pilots clutch release bearing.

4. Try release bearing on transmission retainer to make sure no binding exists.

5. Check release bearing by placing thrust load on bearing by hand and turning bearing race. Replace if bearing feels rough or seems noisy when turning.

6. Clean flywheel face with carbon tetrachloride, sandpaper or steel wool. Inspect pilot bearing in crankshaft for roughness. NOTE: If necessary to replace, see Section 6, ENGINE MECHANICAL FOR REMOVAL AND REPLACEMENT OF PILOT BEARING.

REPLACE

1. Position clutch driven plate so long end of hub is in flywheel and install clutch driven plate and cover assembly on flywheel but do not tighten bolts (install lockwasher under each cover to flywheel bolt).

*NOTE: Align marks placed on flywheel and on cover during disassembly.*

2. Use a spare transmission main drive gear inserted in spline of clutch driven disc to move disc into correct alignment so pilot on end of drive gear will enter clutch pilot bearing. Tighten clutch cover and pressure plate to flywheel bolts one turn at a time until tight, then tighten to 25-35 lb. ft. torque. Remove spare main drive gear used to align clutch disc.

3. Lubricate surface of release fork fingers, which contact release bearing, sides of pressure plate lugs protruding through cover plate stamping, and the release fork ball fulcrum with high melting point wheel bearing lubricant and install release fork.

4. Apply a light coat of grease to inner diameter of clutch release bearing and fill recess in inner diameter of bearing.

5. Install clutch release bearing to fork in flywheel housing.

6. Apply a light coat of high melting point wheel bearing lubricant to full length of outer diameter of transmission release bearing support (retainer).

*CAUTION: Do not overlubricate.*

7. Install flywheel housing and tighten bolts to 30-45 lb. ft. torque.

8. Install transmission. See TRANSMISSION SECTION.

*CAUTION: Use two transmission guide pins in upper holes in clutch housing.*

9. Connect clutch linkage to release fork, Fig. 6D-2 (6 cyl.) or Fig. 6D-3 (8 cyl.).

10. Adjust pedal lash. See lash adjustment under Periodic Service.

## SPECIFICATIONS

Pedal Lash - 3-1/2 turns of adjusting rod from zero lash position.

Disc Facings

| | |
|---|---|
| Type | Single Plate Dry |
| Diameter of Disc | Std.- 9.12 |
| | HD.-10.00 |
| | V-8-10.40 |
| Release Bearing | Sealed Ball Bearing |
| Number of Torsion Springs | 6 |

## TORQUE SPECIFICATIONS

| | Lb. Ft. |
|---|---|
| Clutch Pressure Plate to Flywheel Bolts | 20-35 |
| Flywheel Housing to Engine Block Bolts | 30-45 |
| Clutch Fork Rod Adjusting Lock Nut | 8-12 |
| Transmission and Extension to Flywheel Housing Bolts | 45-60 |
| Countershaft Stud Assembly to Cylinder Block | 25-35 |
| Countershaft Stud to Side Rail Nut | 25-35 |

| | Lb. In. |
|---|---|
| Clutch Housing Cover to Flywheel Housing Screw | 55-70 |
| Control Rod Bellows Retainer to Floor Pan Screw | 10-15 |

# STANDARD TRANSMISSION AND GEARSHIFT CONTROL

## CONTENTS OF THIS SECTION



## DESCRIPTION

The three-speed synchromesh transmission is used as standard equipment on all 6 and 8 cylinder Tempest models.

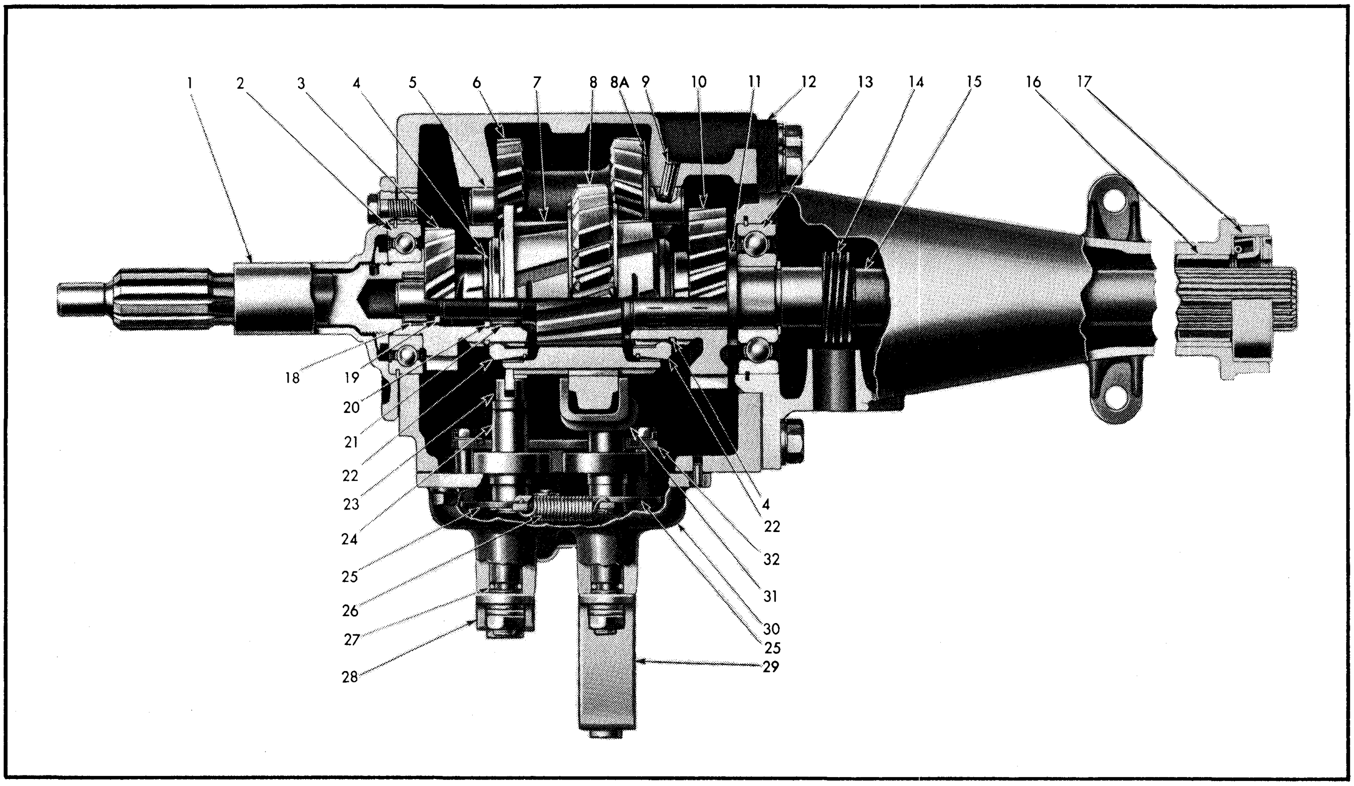
It consists of two basic sections; the transmission case, or forward section, and the case extension, or rear section. The forward section contains the main gear assemblies, clutch assembly and synchronizing mechanism, while the rear section acts as a supporting member for the entire unit.

Gearshifting is manual through a concentric steering column gearshift mechanism (Fig. 7-8 & 7-9) which activates two rods connected to the shifter levers at the transmission case side cover. A floor mounted shift control lever, with or without a console, is available as optional equipment. (Fig. 7-10 & 7-11). Shifting of gears is accomplished by the movement of two shift forks which directly engage the gears to be shifted.

## DESIGN

The transmission incorporates all helical gears which are machined from drop-forged steel gear blanks, heat-treated and shot peened for strength and long life. The shafts are machined from high grade steel, heat-treated and ground to close limits.

The transmission assembly consists of five basic gears of varying size and design. These gears are




1. Clutch Gear Bearing Retainer
2. Clutch Gear Bearing
3. Clutch Gear
4. Energizing Spring
5. Reverse Idler Shaft
6. Reverse Idler Gear
7. Second and Third Speed Clutch
8. First and Reverse Sliding Gear
8a. Thrust Bearing and Washer
9. Reverse Idler Shaft Pin
10. Second Speed Gear
11. Thrust Washer
12. Case Extension
13. Mainshaft Rear Bearing
14. Speedometer Drive Gear
15. Mainshaft
16. Bushing
17. Oil Seal
18. Front Pilot Bearing Rollers
19. Thrust Washer
20. Thrust Washer
21. Rear Pilot Bearing Rollers
22. Synchronizer Ring
23. Second and Third Shifter Fork
24. Second and Third Shifter Shaft
25. Detent Cam
26. Detent Cam Spring
27. "O" Ring Oil Seal
28. Second and Third Shifter Lever
29. First and Reverse Shifter Lever
30. Side Cover
31. First and Reverse Shifter Fork
32. Interlock Retainer

Fig. 7-1 Cross Section of Three-Speed Synchromesh Transmission - Top View

so positioned that, when one gear is brought into mesh with another, proper ratios are attained for first, second, third and reverse speeds.

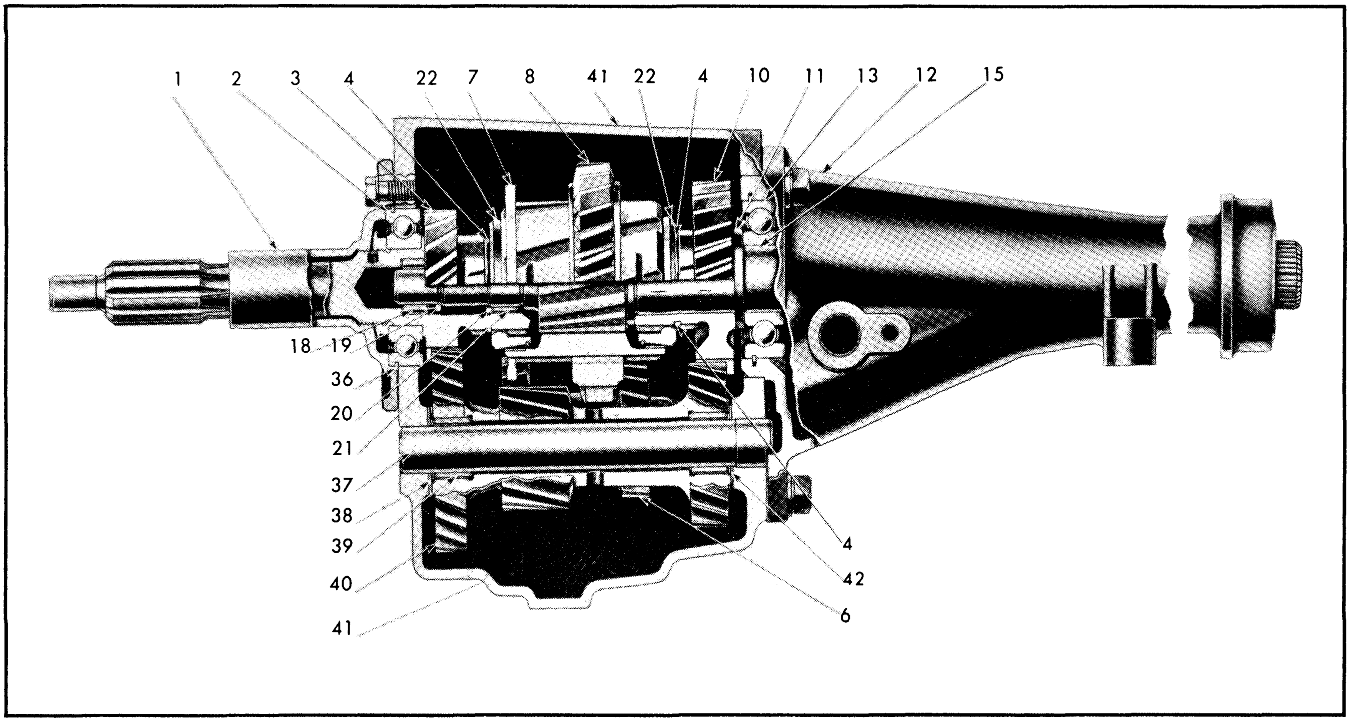
Six cylinder models incorporate gear ratios of 2.94 in first, 1.68 in second and 1.00 in high. Reverse ratio is 2.94:1. Tempests equipped with a V-8 engine use a transmission similar to the one for the six cylinder model, except for gears of coarser teeth for added strength to accept the higher torque output. Gear ratios for this transmission are 2.58 in first, 1.48 in second, 1.00 in high and 2.58 in reverse.

A synchronizing mechanism, consisting of two cone-type synchronizing rings, is incorporated in the second and third speed clutch. It is this mechanism which allows the gears to be meshed properly while in motion.

The rear end of the main drive (clutch) gear is supported by a heavy duty ball bearing at the front end of the transmission case (Fig. 7-1) and is piloted at its front end in an oil impregnated bushing (ball bearing in V-8 engines) mounted in the engine crankshaft.

The front end of the mainshaft is piloted in a double row of needle bearing rollers set into the hollow end of the main drive (clutch) gear and the rear end of the mainshaft is carried by a heavy duty ball bearing located in the face of the rear extension (Fig. 7-1).

The countergear is carried on needle bearing rollers positioned at both ends of the countershaft and thrust is taken on bronze thrust washers located between each end of the gear and the case. Roller




1. Clutch Gear Bearing Retainer
2. Clutch Gear Bearing
3. Clutch Gear
4. Energizing Spring
6. Reverse Idler Gear
7. Second and Third Speed Clutch
8. First and Reverse Sliding Gear
10. Second Speed Gear
11. Thrust Washer
12. Case Extension
13. Mainshaft Rear Bearing
15. Mainshaft
18. Front Pilot Bearing Rollers
19. Thrust Washer
20. Thrust Washer
21. Rear Pilot Bearing Rollers
22. Synchronizer Ring
33. Speedometer Shaft Fitting
34. Lock Plate
35. Speedometer Driven Gear Shaft
36. Snap Ring
37. Countershaft
38. Thrust Washer
39. Roller Bearing
40. Countergear
41. Transmission Case
42. Roller Thrust Washer

Fig. 7-2 Cross Section of Three-Speed Synchromesh Transmission - Side View

bearing thrust washers are installed between the thrust washers and the roller bearings (Fig. 7-2).

The reverse idler gear is carried on ball-indented bronze bushings pressed into front and rear ends of the gear. Forward thrust of the gear is taken on a washer located between the front of the gear and the case, and rearward thrust is taken on a radial roller thrust bearing and washer positioned between gear and case (Fig. 7-1).

The second speed gear floats on the mainshaft, while the first and reverse sliding gear is positioned so that it rides on the second and third speed clutch assembly (Figs. 7-1 and 7-2).

## OPERATION

The main drive (clutch) gear is in constant mesh with the countergear, which in turn is in constant mesh with the reverse idler gear and second speed gear. Therefore, with the engine running and the engine clutch engaged, torque is imparted to the main drive (clutch) gear, countergear, second speed gear, and reverse gear at all times.

### *OPERATION IN NEUTRAL (Fig. 7-3)*

In neutral, the first and reverse sliding gear is positioned so that it does not mesh with the countergear or the reverse idler gear. The second and third speed clutch is positioned so that it does not engage the second speed gear or the main drive clutch gear. Therefore, with engine clutch engaged, the main drive (clutch) gear, countergear, second speed gear, and reverse idler gear are turning, but no power is being transmitted through the mainshaft.

### *OPERATION IN FIRST (Fig. 7-4)*

In first speed, the first and reverse sliding gear is moved forward to engage the countergear, which is being turned by the main drive (clutch) gear. This engagement activates the first and reverse sliding

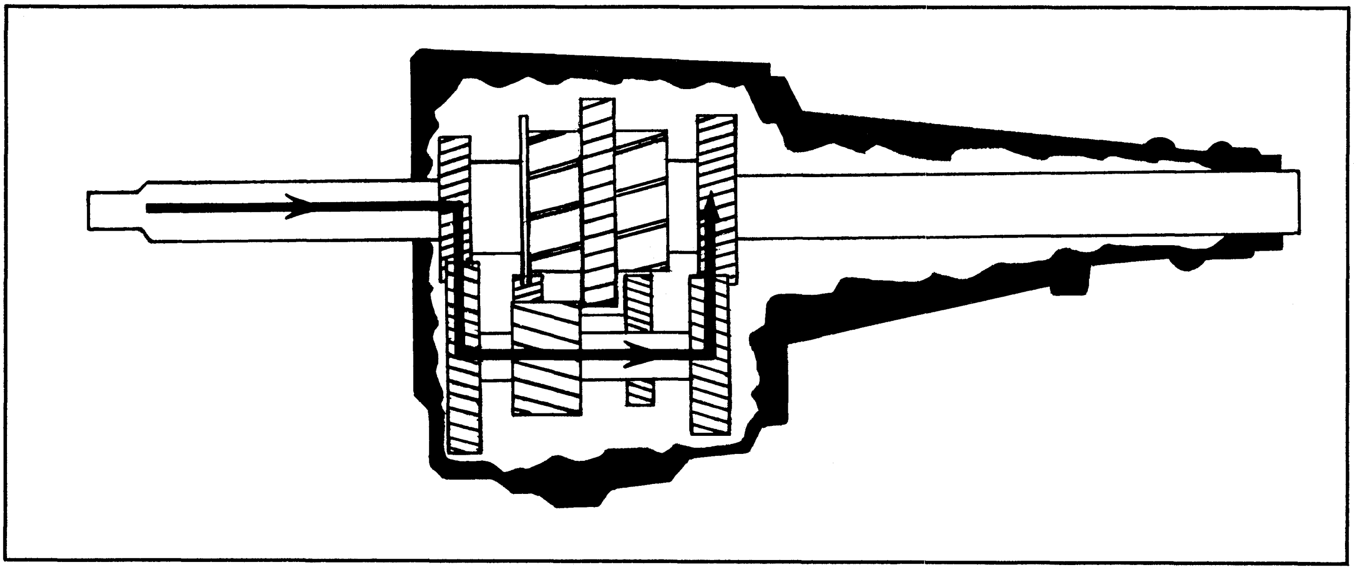


Fig. 7-3 Three-Speed Synchromesh - Power Flow in Neutral

gear which rides on, and is splined to the second and third speed clutch (sleeve). Because the second and third speed clutch is splined to the mainshaft, torque applied to the clutch through the first and reverse sliding gear is imparted directly to the mainshaft.

*OPERATION IN SECOND (Fig. 7-5)*

In second speed, the first and reverse sliding gear is moved to a neutral position. The second and third speed clutch, which is splined to the mainshaft, is moved toward the rear of the transmission to engage the second speed gear, which floats on the mainshaft. Since the main drive (clutch) gear and second speed gear are always in mesh with the countergear, and since the second and third speed clutch is splined to the mainshaft, engaging the second and third speed clutch with the second speed gear will cause the mainshaft to turn.

*OPERATION IN THIRD (Fig. 7-6)*

In third speed, or direct drive, the second and third speed clutch is disengaged from the second speed gear and moved forward until it engages the main drive (clutch) gear. Since the second and third speed clutch is splined to the mainshaft, torque is

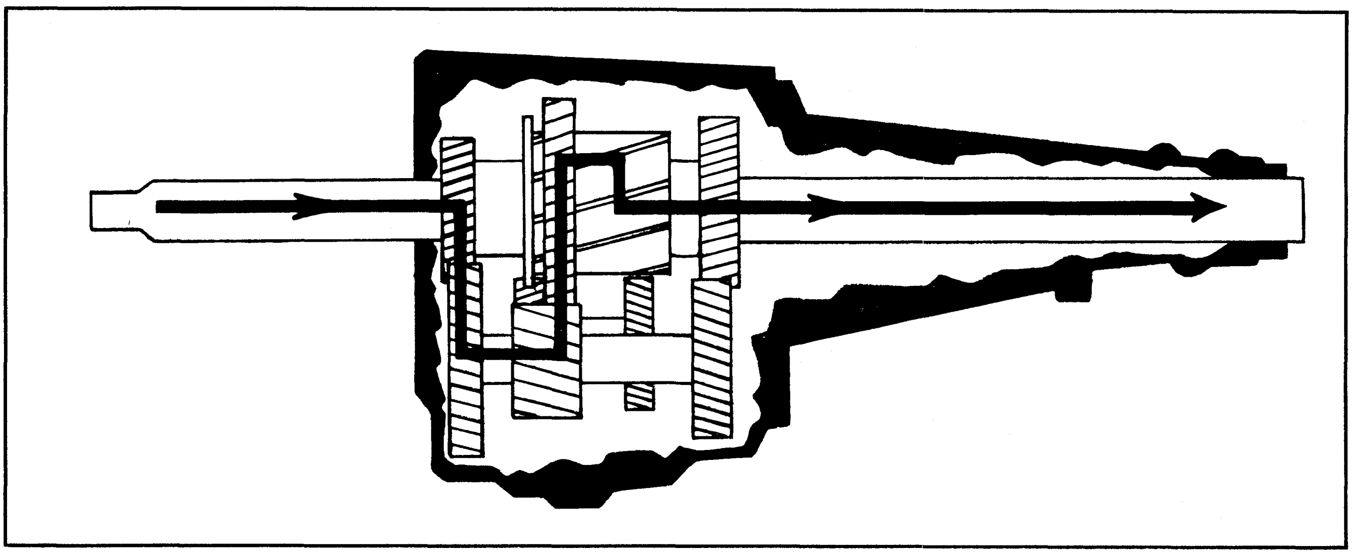


Fig. 7-4 Three-Speed Synchromesh - Power Flow in First Speed

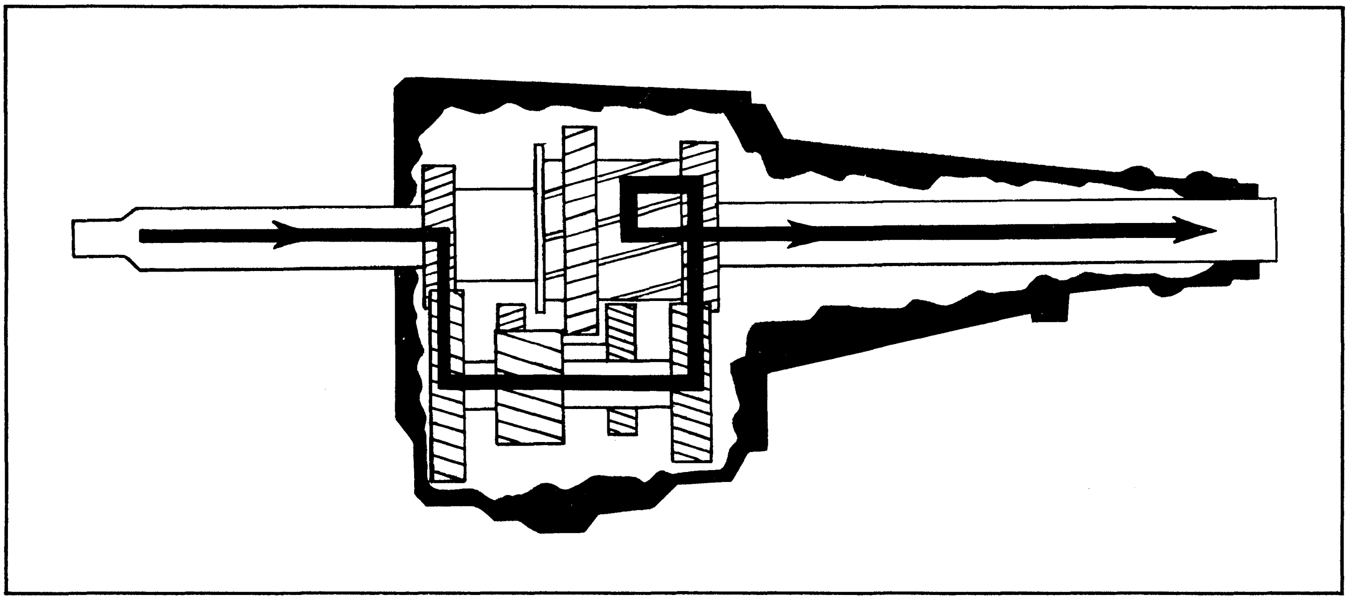


Fig. 7-5 Three-Speed Synchromesh - Power Flow in Second Speed

applied directly to the mainshaft in the direction of engine rotation at engine speed.

### OPERATION IN REVERSE (Fig. 7-7)

In reverse speed, the second and third speed clutch assumes a neutral position and the first and reverse sliding gear is moved rearward to engage the reverse idler gear. Since the first and reverse sliding gear rides on, and is splined to, the second and third speed clutch (sleeve), which is splined to the mainshaft, the power flow is directed through the main drive (clutch) gear, countergear, reverse idler gear, and first and reverse sliding gear to the mainshaft. As power flows from reverse idler gear to first and reverse sliding gear, the direction of rotation is reversed, making it opposite that of the engine.

## PERIODIC SERVICE

### TRANSMISSION

No periodic service of the transmission is required except checking for leaks and proper lubricant level every 6000 miles.

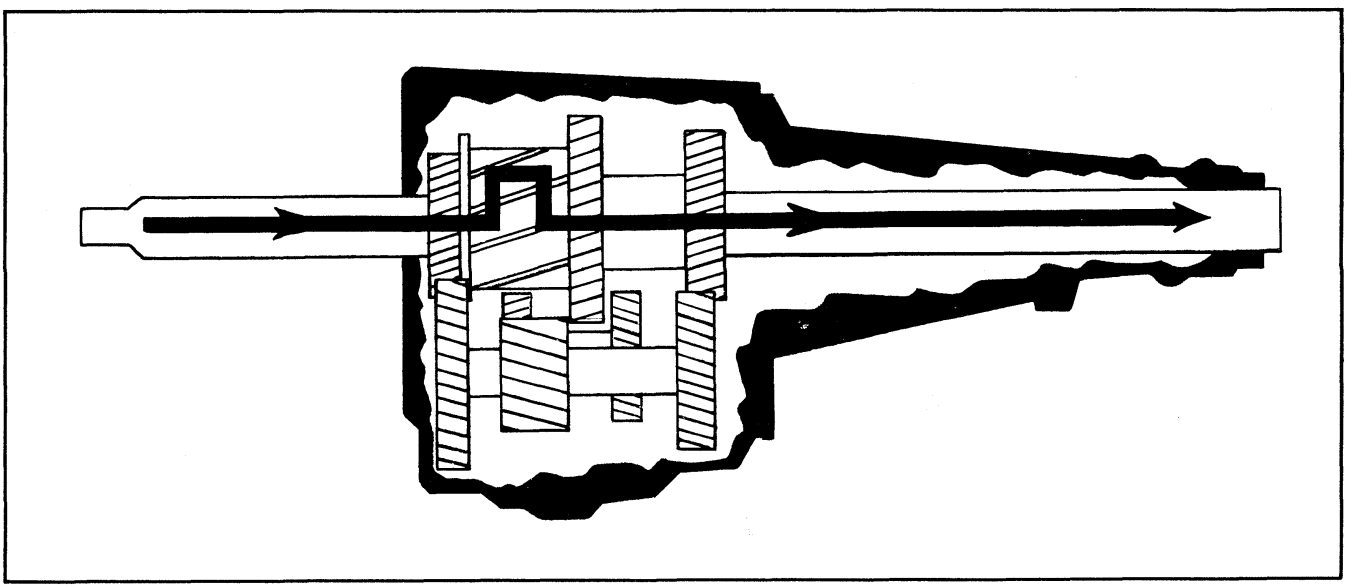


Fig. 7-6 Three-Speed Synchromesh - Power Flow in Third Speed

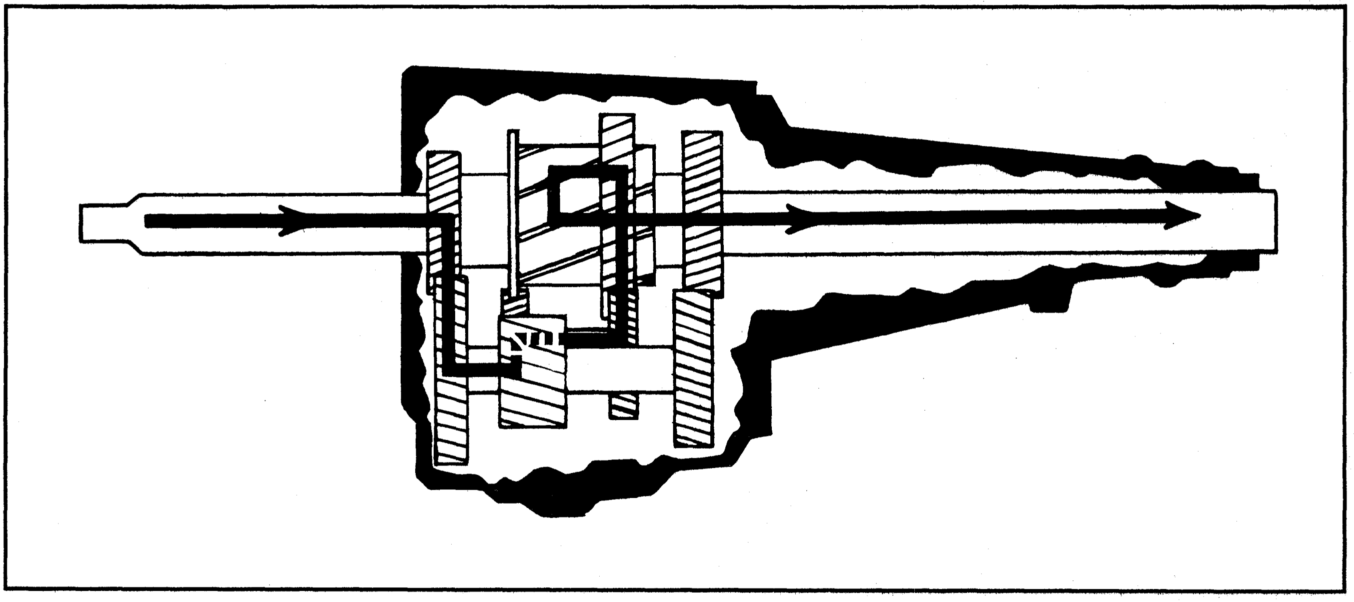


Fig. 7-7 Three-Speed Synchromesh - Power Flow in Reverse

If there is evidence of leakage, the leak should be corrected and lubricant added, if needed. Refill capacity is 1.8 pints.

Use SAE 90 "Multi-purpose Gear Lubricant". No special additive to this lubricant is required or recommended.

### SHIFT CONTROL

No periodic service of the shift control is required. Certain parts are lubricated on assembly and require further lubrication only when parts become dry and sticky.

## ADJUSTMENTS ON CAR

GEARSHIFT LINKAGE ADJUSTMENT (Column) (Fig. 7-8 & 7-9)

*NOTE: In cases where the linkage has been disconnected, lubricate linkage joints with chassis grease, assemble shift rods to column levers and transmission levers and tighten swivel nuts finger tight.*

1. Position selector lever at upper end of column in neutral.

2. Retain levers at lower end of steering column in neutral.

3. Loosen 2 swivel nut assemblies.

4. Position both levers on transmission in neutral.

5. Tighten swivel nuts to 8-12 lb. ft. torque.

6. Check complete shift pattern with engine off. Start engine and repeat complete shift pattern.

*NOTE: If adjustments are made as outlined above and clutch lash is correct (see Section 6D) shifting should be smooth in and out of any gear with proper movement of selector lever by the operator.*

GEARSHIFT LINKAGE ADJUSTMENT (Floor) (Fig. 7-10)

*NOTE: In cases where the linkage has been disconnected, lubricate linkage joints with chassis grease, assemble shift rods to transmission levers and bracket assembly control levers and tighten swivel nuts finger tight.*

1. Position selector lever in neutral position.

2. Loosen two swivel nut assemblies.

3. Insert 1/4 diameter gauge pin into bracket and lever assembly control levers and align them in neutral position.

4. Position levers on transmission in neutral position.

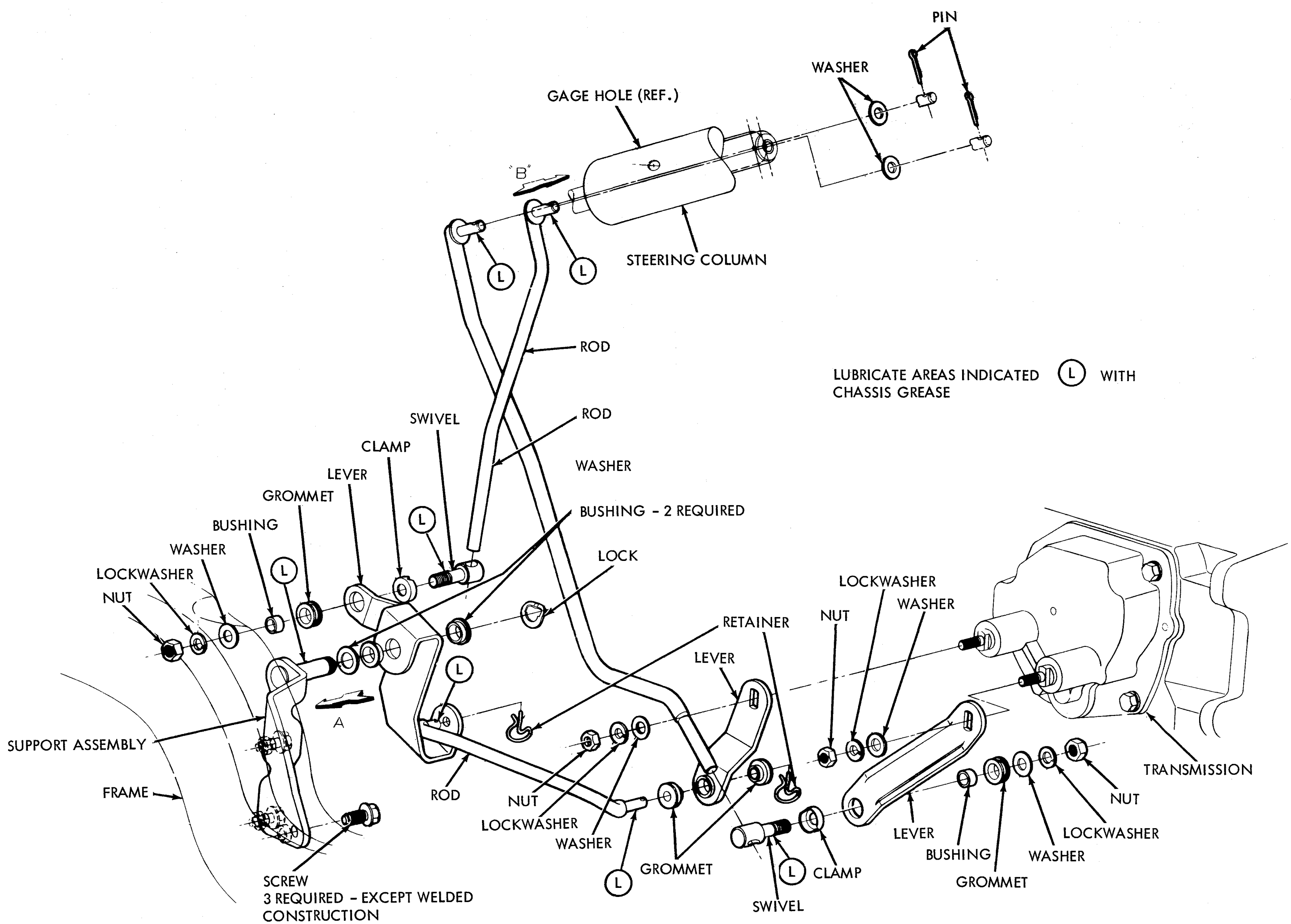



Fig. 7-8 Gearshift Controls (Column) - 6 Cyl.

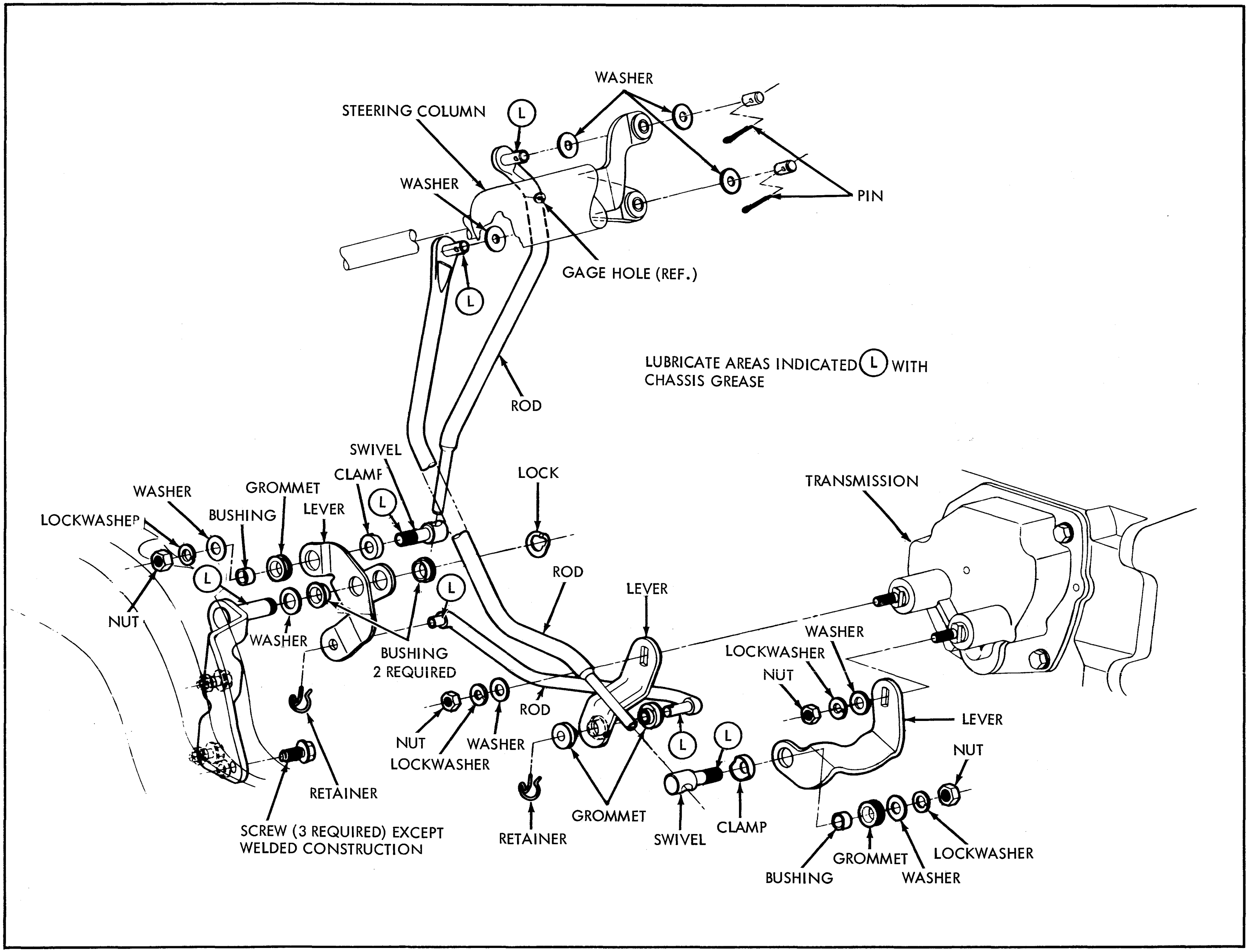



Fig. 7-9 Gearshift Controls (Column) - 8 Cyl.

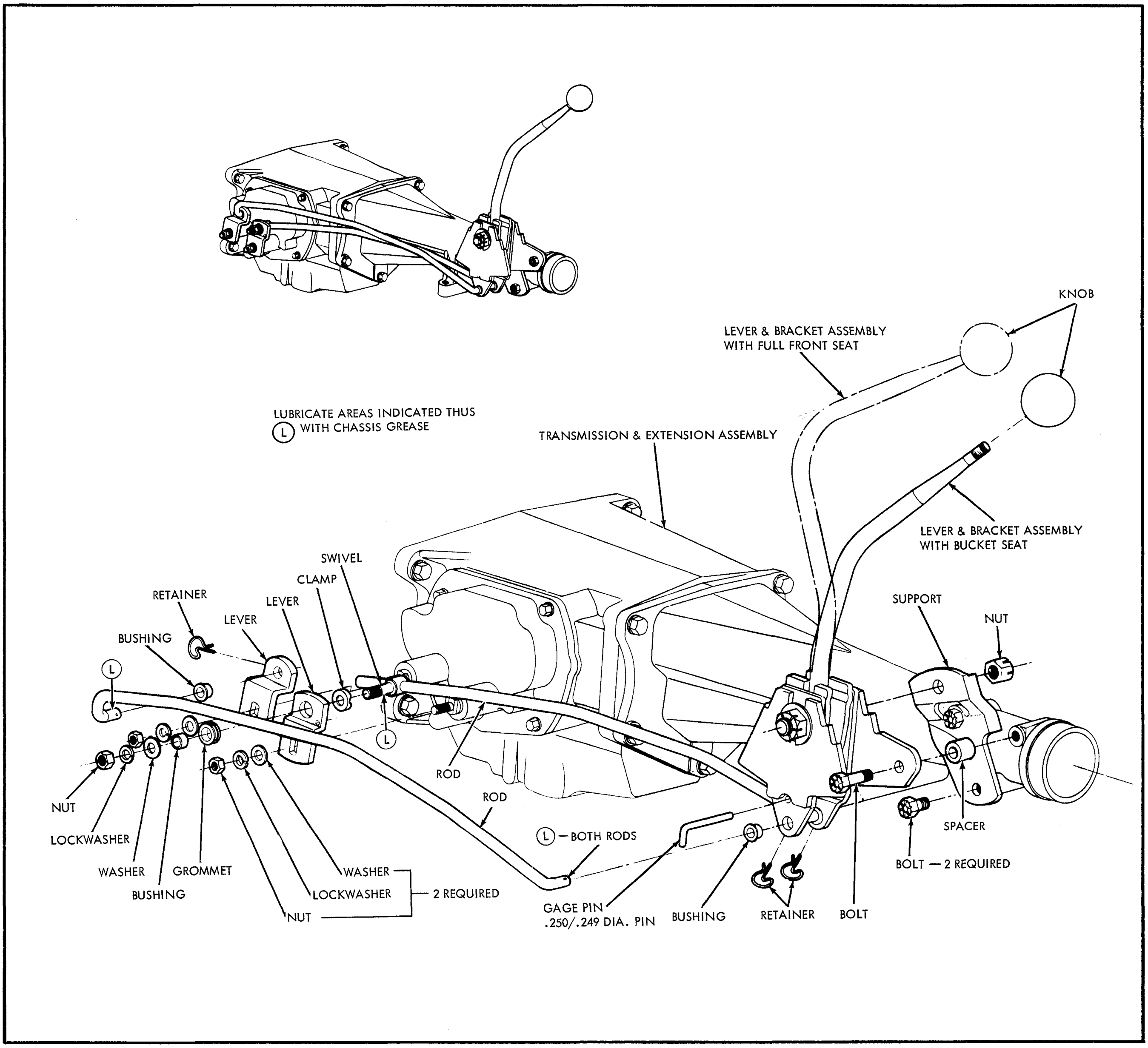



Fig. 7-10 Gearshift Controls (Floor)

5. Tighten swivel nut assemblies to 8-12 lb. ft. torque.

6. Remove gauge pin.

7. Check complete shift pattern with engine off. Start engine and repeat complete shift pattern.

*NOTE: If shift rod adjustments are made as outlined above and clutch lash is correct (see Section 6D) shifting should be smooth in and out of any gear, with proper movement of selector lever by operator.*

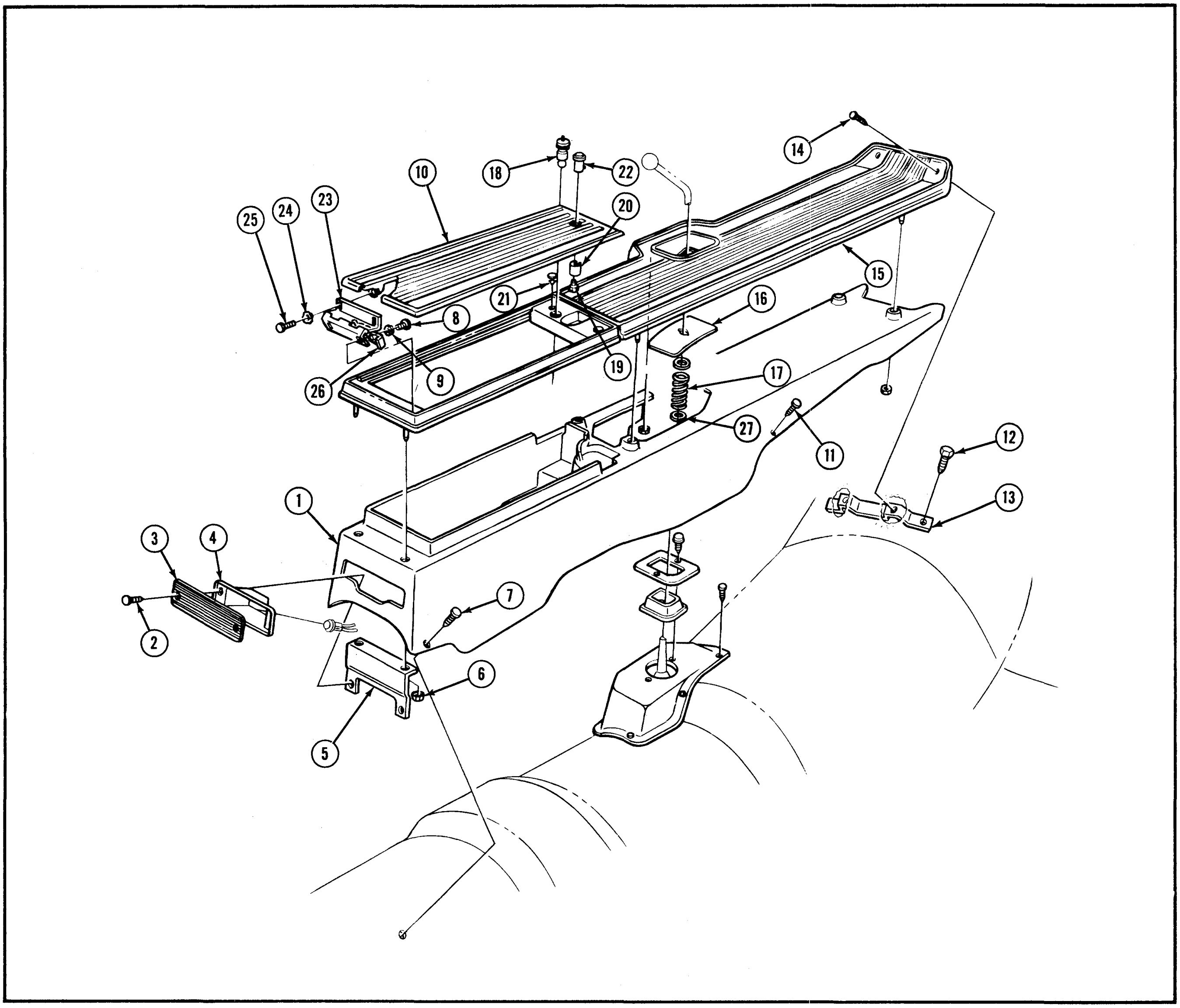
## MINOR REPAIRS

### SHIFT LINKAGE AND STEERING COLUMN

If shift rods or second and third shift lever rod assembly are to be replaced, disconnect them as required. Remove and overhaul of the steering column is covered in section 9.

### SPEEDOMETER DRIVEN GEAR—REMOVE

1. Disconnect speedometer cable.




| | | | |
|---|---|---|---|
| 1. Console | 8. Screw | 15. Moulding Assy. | 22. Lock Assy. |
| 2. Screw | 9. Washer | 16. Cover | 23. Hinge Assy. |
| 3. Lens | 10. Door | 17. Spring | 24. Washer |
| 4. Lamp Assy. | 11. Screw & Sealer Assy. | 18. Switch & Lamp Assy. | 25. Screw |
| 5. Retainer | 12. Screw & Sealer Assy. | 19. Screw | 26. Spring |
| 6. Nut | 13. Bracket | 20. Retainer | 27. Washer |
| 7. Screw & Sealer Assy. | 14. Screw | 21. Bumper | |

Fig. 7-11 Exploded View - Console

2. Remove retainer to extension bolt and lock washer and remove retainer.

3. Insert screwdriver in lock plate slot in fitting and pry fitting, gear and shaft from extension.

4. Pry "O" ring from groove in fitting.

5. Check gear, shaft and fitting for wear and replace if necessary.

*NOTE: Check for correct usage by referring to speedometer drive and driven gear usage chart in Section 1.*

### SPEEDOMETER DRIVEN GEAR—REPLACE

1. Install new "O" ring in groove of speedometer gear and sleeve assembly.

2. Hold the assembly so slot is toward boss on extension and insert assembly into extension.

3. Push assembly into extension until retainer can be inserted in groove.

4. Install retainer to extension bolt and lock washer and tighten 35-60 lb. in.

5. Connect speedometer cable to speedometer driven gear and sleeve assembly.

### *TRANSMISSION EXTENSION OIL SEAL—REMOVE*

To inspect or replace the rear extension oil seal, it is necessary to remove the propeller shaft drive line assembly from the vehicle.

1. Remove U-bolt nuts, lock plates and U-bolts from rear axle drive pinion flange.

2. Use suitable rubber band to hold bearings onto journals, if tie wire has been removed, to prevent loss of needle bearings when rear joint is disconnected.

3. Slide propeller shaft assembly rearward to disengage yoke from splines on transmission mainshaft and remove.

4. Using punch or other suitable tool (Fig. 7-12), loosen seal from extension and remove.

5. Wash counterbore with cleaning solvent and inspect for damage.

6. Inspect propeller shaft yoke hub for nicks, burrs or scratches which would cut new seal or cause seal to leak or damage bushing.

### TRANSMISSION EXTENSION OIL SEAL - REPLACE

1. Coat new seal with sealing compound and start straight in bore of case extension. Using installer J-5154-A, tap seal into counterbore (Fig. 7-13).

2. Install propeller shaft assembly by reversing steps 1 through 3 under removal of oil seal.

### *TRANSMISSION SIDE COVER—REMOVE*

It is not necessary to remove the transmission from the vehicle for inspection or replacement of parts in the transmission side cover assembly, but the side cover assembly itself must be removed from the transmission case.

1. Disconnect first and reverse shifter rod from shift lever at transmission by removing swivel nut assembly.

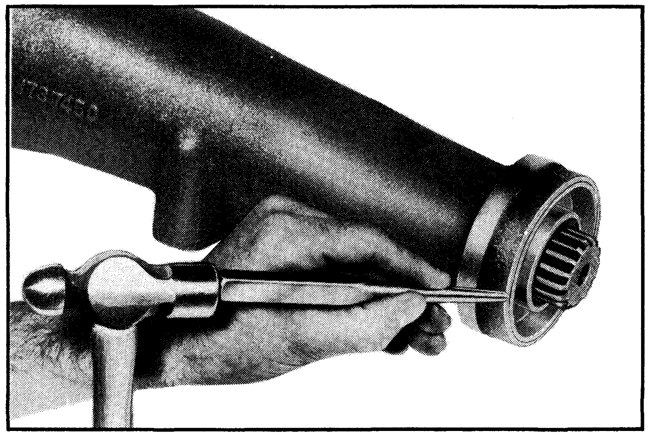


Fig. 7-12 Removing Extension Oil Seal

2. Disconnect lower end of second and third shifter rod by removing retainer.

3. Remove four transmission cover retaining bolts and lockwashers.

4. Remove side cover and gasket.

### *TRANSMISSION SIDE COVER—DISASSEMBLE*

1. Remove nuts and locks from shifter interlock retainer and remove retainer (Fig. 7-14).

2. Remove detent cam spring to release detent cam (Fig. 7-14).

3. Remove both shifter shafts and shift fork assemblies.

4. Remove retaining ring and remove detent cam (Fig. 7-14).

5. Remove shifter interlock shaft.

6. Inspect and replace necessary parts.

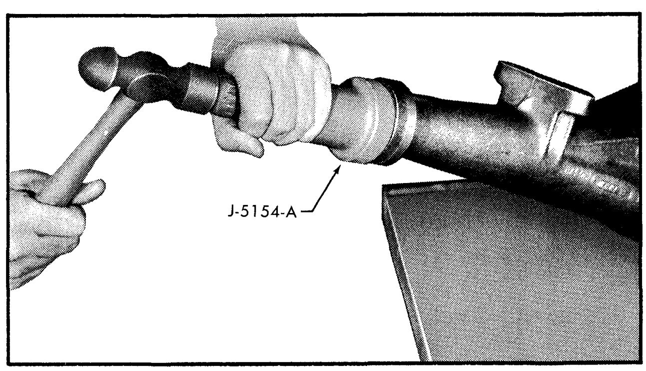



Fig. 7-13 Installing Extension Oil Seal

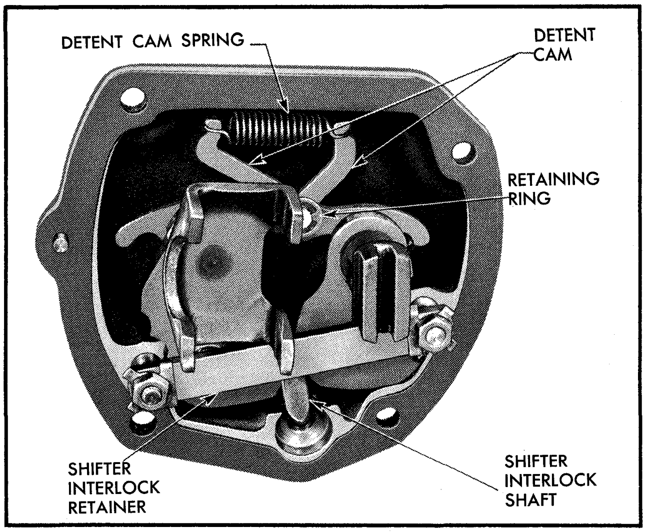



Fig. 7-14 Transmission Side Cover - Inner View

### TRANSMISSION SIDE COVER—ASSEMBLE AND REPLACE

1. Install shifter interlock shaft.

2. Install detent cam and retaining ring.

3. Install shifter shafts and shift fork assemblies.

4. Install detent cam spring.

5. Install shifter interlock retainer and locks, and install interlock retainer nuts, tightening securely.

6. Install outer shifter levers on shifter shaft and tighten bolts 10-20 lb. ft. torque.

7. Install side cover gasket.

8. Place transmission gears and shifter forks in neutral position and install cover.

*NOTE: Flanged side on first and reverse shifter fork must face rear of transmission as shown in Fig. 7-15.*

9. Apply special sealer compound to threads of four cover retaining bolts and install bolts and lock washers, tightening evenly to prevent cover distortion. Torque to 15 to 18 lb. ft.

10. Install first and reverse shift lever (Fig. 7-8, 7-9, 7-10).

11. Install second and third shift lever and connect all rods.

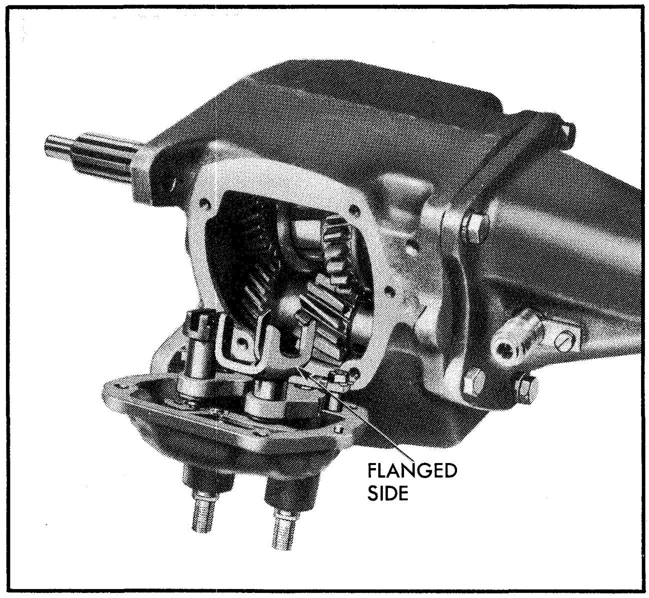



Fig. 7-15 Positioning First and Reverse Shifter Fork in Transmission Side Cover

12. Adjust linkage.

13. Remove filler plug at side of transmission and add SAE 90 "Multi-purpose Gear Lubricant". Lubricant level should be approximately level with bottom of filler plug hole.

## MAJOR REPAIRS

### TRANSMISSION—REMOVE AND OVERHAUL

1. Remove propeller shaft drive line assembly as follows:

a. Remove U-bolt nuts, lock plates and U-bolts from rear axle drive pinion flange.

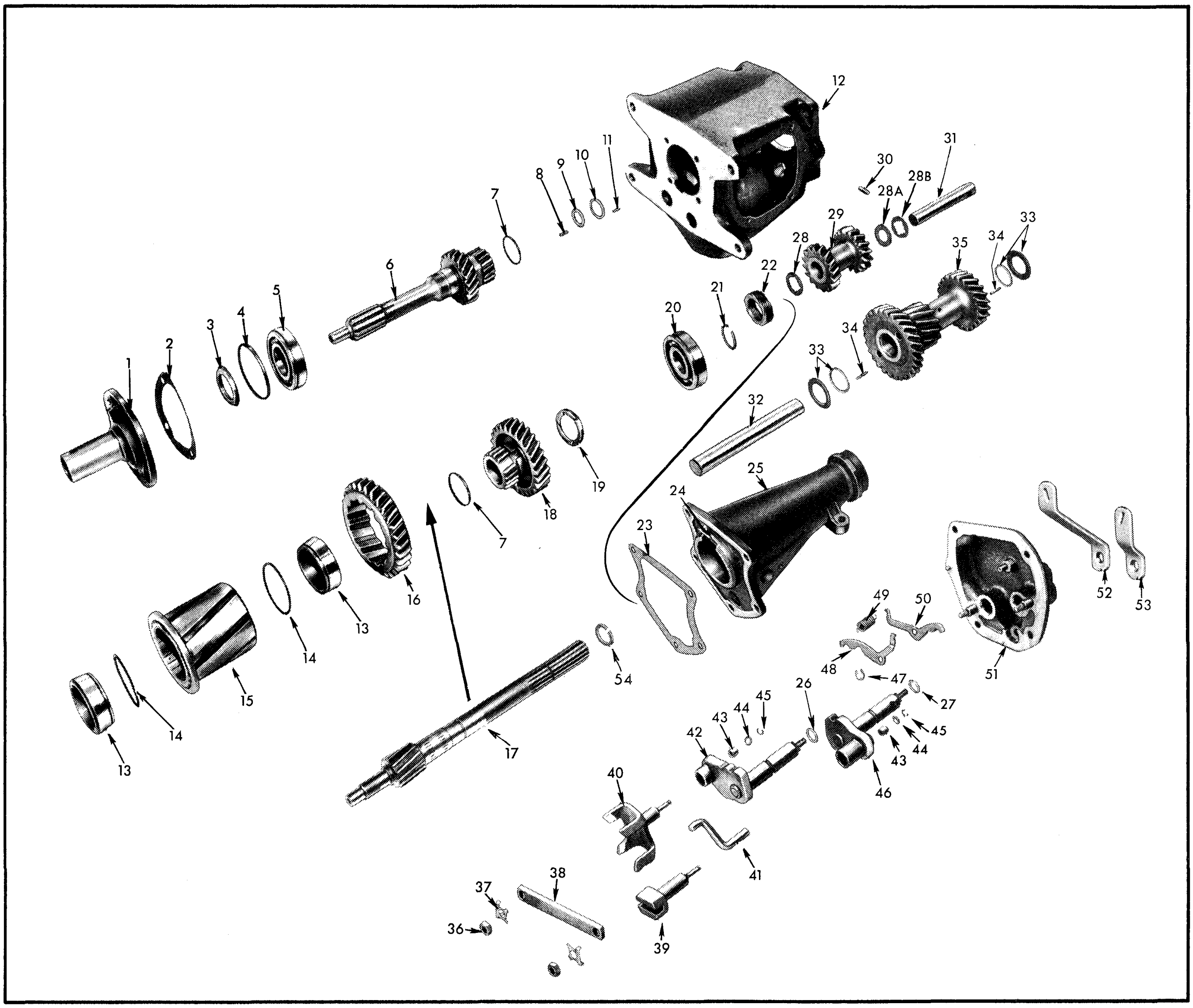
b. Use a suitable rubber band to hold bearing onto journals, if tie wire has been removed, to prevent loss of needle bearings when rear joint is disconnected.

c. Remove complete drive line assembly by sliding rearward to disengage yoke from splines on transmission mainshaft.

1. Disconnect speedometer cable from speedometer driven gear.

3. Disconnect shift linkage from transmission.

*NOTE: If car is equipped with gear-shift control on the floor, also remove the lever and bracket assembly from side of the transmission extension.*




1. Clutch Gear Bearing Retainer
2. Bearing Retainer Gasket
3. Bearing Nut and Oil Slinger
4. Bearing Snap Ring
5. Clutch Gear Bearing
6. Clutch Gear
7. Energizing Spring
8. Front Pilot Bearing Roller
9. Thrust Washer
10. Thrust Washer
11. Rear Pilot Bearing Rollers
12. Transmission Case
13. Synchronizer Ring
14. Snap Ring
15. Second and Third Speed Clutch
16. First and Reverse Sliding Gear
17. Mainshaft
18. Second Speed Gear
19. Thrust Washer
20. Mainshaft Rear Bearing
21. Snap Ring
22. Speedometer Drive Gear
23. Case Extension Gasket
24. Rear Bearing Snap Ring
25. Case Extension
26. First and Reverse Shifter Shaft "O" Ring
27. Second and Third Shifter Shaft "O" Ring
28. Thrust Washer
28a. Thrust Bearing
28b. Thrust Bearing Washer
29. Reverse Idler Gear
30. Reverse Idler Shaft Pin
31. Reverse Idler Shaft
32. Countershaft
33. Countergear and Roller Thrust Washers
34. Bearing Roller
35. Countergear
36. Shifter Interlock Retainer Stud Nut
37. Shifter Interlock Retainer Stud Nut Lock
38. Shifter Interlock Retainer
39. Second and Third Shifter Fork
40. First and Reverse Shifter Fork
41. Shifter Interlock Shaft
42. First and Reverse Shifter Shaft & Plate Ass'y
43. Shifter Fork Spacer
44. Shifter Fork Washer
45. Shifter Fork Retainer
46. Second and Third Shifter Shaft & Plate Ass'y.
47. Detent Cam Retainer
48. First and Reverse Detent Cam
49. Detent Cam Spring
50. Second and Third Detent Cam
51. Side Cover
52. First and Reverse Shifter Lever (Outer)
53. Second and Third Shifter Lever (Outer)
54. Special Snap Ring

Fig. 7-16 Three-Speed Synchromesh Transmission - Exploded View

4. Support rear of engine with floor jack.

5. Remove two transmission insulator to cross member retaining bolts. (See Fig. 6-14, 6 cyl., Fig. 6-94, 8 cyl.).

6. Remove upper transmission to clutch housing bolts and insert transmission aligning studs J-1126.

*CAUTION: Aligning studs must be used since they support transmission and prevent distortion of clutch driven plate hub when lower transmission bolts are removed.*

7. Remove lower transmission to clutch housing bolts, tilt rear of extension upward to disengage bracket studs from cross member support and withdraw transmission from clutch housing.

8. When transmission is free of clutch housing, tilt front downward and remove.

TRANSMISSION - DISASSEMBLE

1. Remove four cover to transmission retaining bolts and remove cover and gasket.

*NOTE: If cover is to be disassembled for inspection and replacement of worn parts, follow procedures 1 through 6 under TRANSMISSION SIDE COVER - DISASSEMBLE.*

2. Remove insulator assembly from rear extension.

3. Remove extension to transmission case bolts and lockwashers.

4. Carefully pull extension and mainshaft assembly out of transmission case, leaving second and third speed clutch assembly and first and reverse sliding gear in case (Fig. 7-17). Do not force mainshaft. Slowly rotate mainshaft and second speed gear to obtain alignment of synchronizing clutch teeth and splines on mainshaft.

*NOTE: Care must be taken when pulling mainshaft from rear of case to prevent needle bearings in main drive (clutch) gear from dropping into case.*

5. Slide first and reverse gear from second and third speed clutch and remove through side opening in transmission case.

6. Remove second and third speed clutch from main drive (clutch) gear.

7. Remove 24 rear and 14 larger front pilot bearing rollers and thrust washers from inside the main drive (clutch) gear pilot hole (Fig. 7-16).

8. Remove the four main drive (clutch) gear bearing retainer bolts and lockwashers and remove retainer.

9. Remove bearing retainer gasket.

10. Remove countershaft by tapping it from front to rear of case with a brass drift approximately 1/4 inch. Complete removal of countershaft using loader J-5777 Fig. 7-18). Lower the countergear, with loader J-5777 still in place, to bottom of case.

*NOTE: Countergear must be lowered before removing main drive (clutch) gear to prevent clutch gear bearing from striking countergear.*

11. Remove main drive (clutch) gear bearing snap ring (Fig. 7-18).

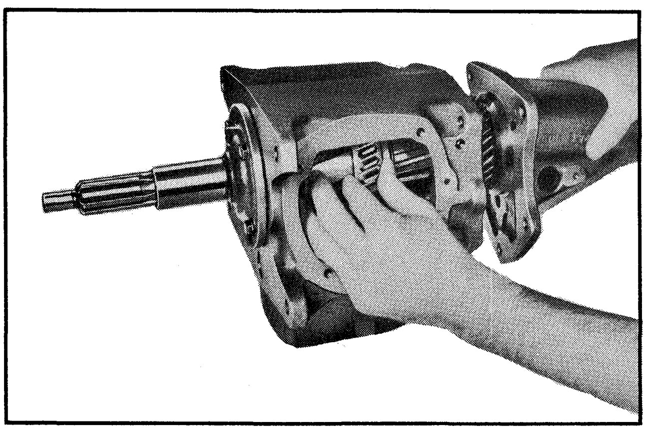


Fig. 7-17 Removal of Mainshaft

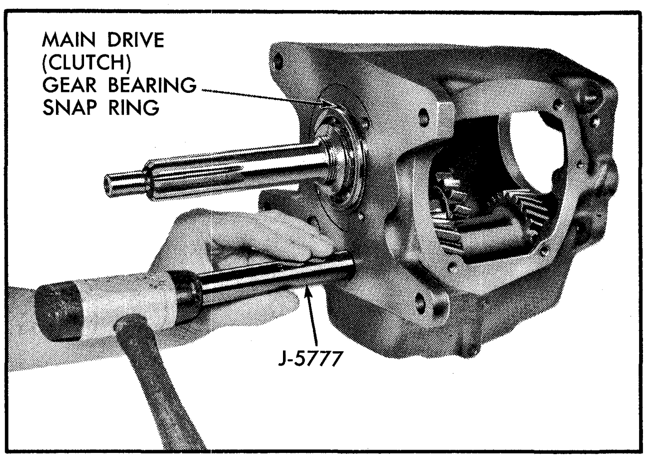



Fig. 7-18 Driving Countershaft Out of Transmission Case

12. Using soft hammer, tap front end of shaft, moving main (clutch) gear and bearing assembly into case. Remove through side opening (Fig. 7-19).

13. Remove countergear from rear of case and remove from countergear.

14. Remove thrust washers and 25 needle bearing rollers from each end of countergear.

15. Tap reverse idler shaft lock pin into shaft (Fig. 7-20). The pin is shorter than the diameter of the shaft so shaft may be removed when pin is driven in.

16. Using a drift pin, tap rear of reverse idler shaft, driving out case plug ahead of shaft.

*NOTE: Do not turn shaft while removing as lock pin may drop down between idler gear bushings.*

17. Remove reverse idler gear, front thrust washer, radial roller thrust bearing and rear thrust bearing washer.

18. To remove mainshaft from rear extension, remove speedometer driven gear assembly as described on page 7-9 under SPEEDOMETER DRIVEN GEAR - REMOVE, steps 1 through 5.

19. Remove rear extension to housing gasket.

20. Expand rear bearing snap ring, using tool J-932 (Fig. 7-21) and, while snap ring is expanded, tap rear of shaft with soft hammer to bring mainshaft assembly forward and out of extension.

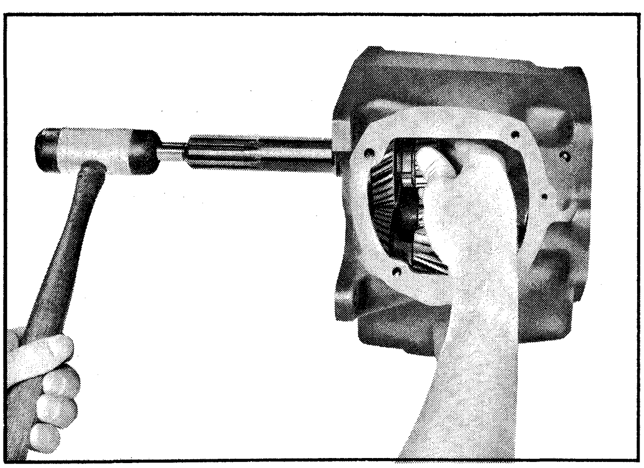


Fig. 7-19 Removing Clutch Gear and Bearing Assembly

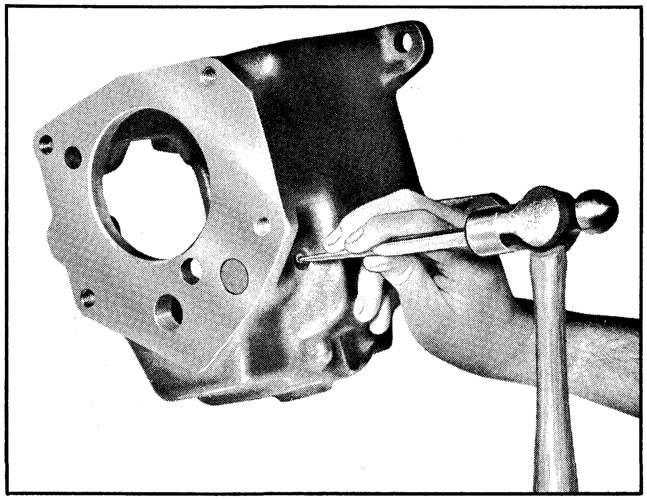


Fig. 7-20 Driving Reverse Idler Shaft Lock Pin into Shaft

MAINSHAFT ASSEMBLY - DISASSEMBLE

1. Remove special snap ring from end of mainshaft.

2. Press speedometer drive gear off mainshaft, using suitable split plates in an arbor press (Fig. 7-22).

3. Remove rear bearing to mainshaft snap ring and press bearing off shaft.

4. Remove second speed gear thrust washer and second speed gear.

MAIN DRIVE (CLUTCH) GEAR - DISASSEMBLE

1. Place main drive (clutch) gear in a vise with soft jaws and, using tool J-933, remove bearing retainer nut and oil slinger (Fig. 7-23).

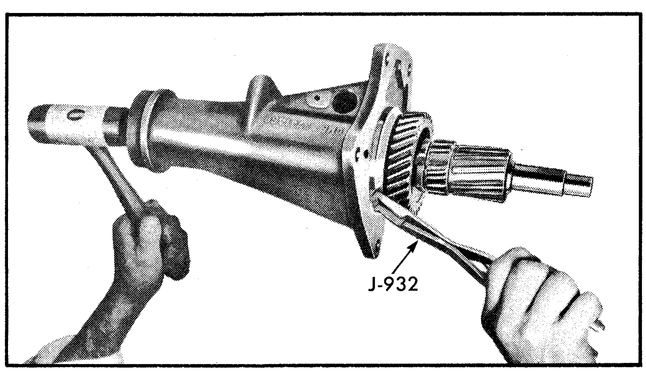



Fig. 7-21 Removing Mainshaft from Extension Housing

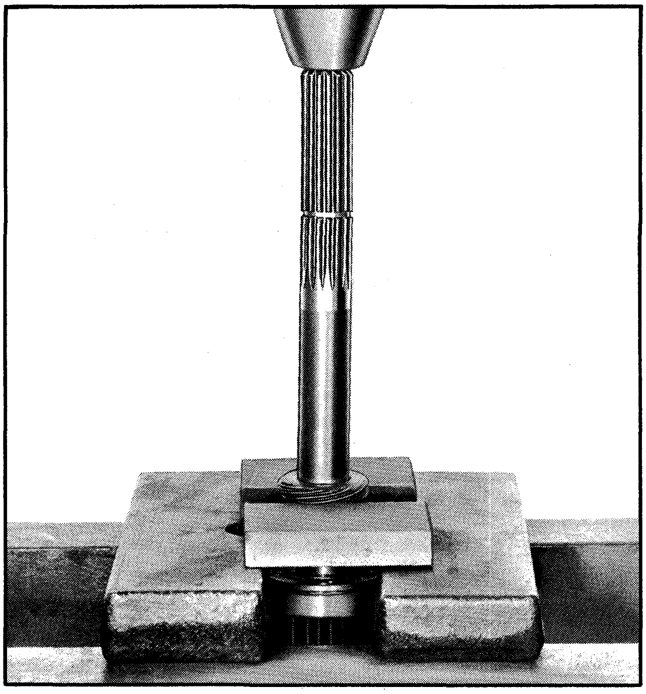


Fig. 7-22 Removing Speedometer Drive Gear

*NOTE: The retaining nut and oil slinger is a one-piece steel casting machined with a left-handed thread and locked in place on the main drive (clutch) gear shaft by being staked into a hole provided for that purpose.*

2. Install main drive (clutch) gear and bearing in transmission case and install snap ring on bearing.

3. Support rear of case in arbor press and press main drive (clutch) gear shaft from bearing (Fig. 7-24). Tap bearing from case.

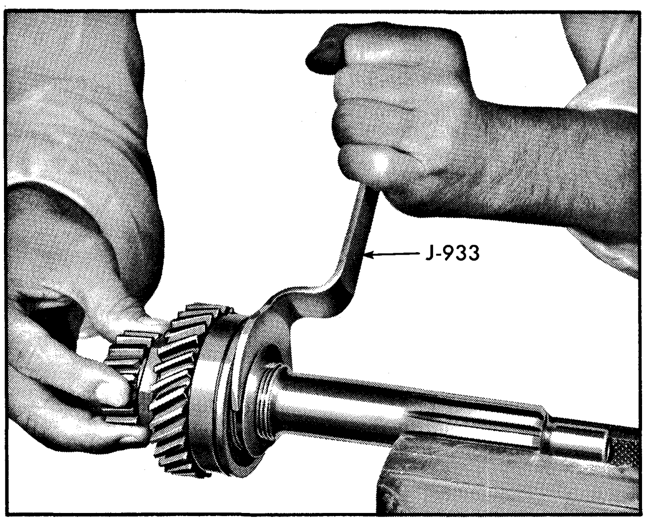



Fig. 7-23 Removing or Installing Oil Slinger

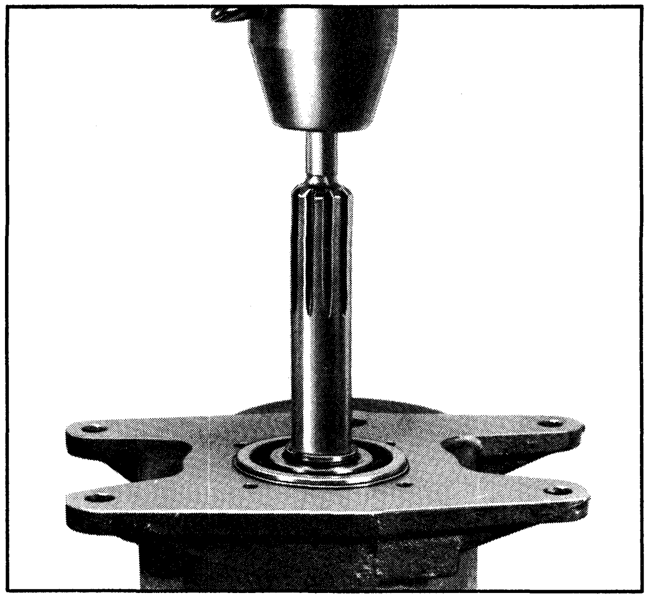


Fig. 7-24 Removing Clutch Gear Bearing

CLUTCH (SLEEVE) AND SYNCHRONIZER RINGS - DISASSEMBLE

1. Turn one synchronizer ring in the clutch (sleeve) until the ends of the ring retainer (snap ring) can be seen through the slot in clutch sleeve.

2. Using tool J-932, expand ring retainer in the counterbore in clutch sleeve (Fig. 7-25) and withdraw synchronizer ring.

3. Remove other synchronizer ring in same manner.

SYNCHRONIZER ENERGIZER SPRINGS - REMOVE

Under normal operation, it should never be necessary to replace the energizing springs, however, should an energizing spring be removed for any reason, a new spring should be installed. The synchronizer energizing spring may be removed by slipping a thin blade under the spring and raising it sufficiently to slide it over the clutch teeth.

TRANSMISSION CASE EXTENSION OIL SEAL AND BUSHING - REMOVE

1. Using punch or other suitable tool (Fig. 7-12), loosen oil seal from rear extension and remove.

*NOTE: Old oil seal should always be discarded after removal from extension.*

2. Using tool J-6399, drive bushing from rear into case extension (Fig. 7-26).

TRANSMISSION CASE AND EXTENSION

1. Wash transmission case and extension outside and inside with cleaning solvent and closely inspect for cracks.

2. Inspect faces for burrs or nicks and, if any are present, dress them off with a fine cut mill file.

3. Inspect transmission case extension bushing for excessive wear and replace if necessary.

BALL BEARINGS

1. Wash bearings thoroughly in cleaning solvent.

2. Blow out bearings with compressed air.

*CAUTION: Do not allow the bearings to spin, but turn them slowly by hand. Allowing bearings to spin will damage the race and balls.*

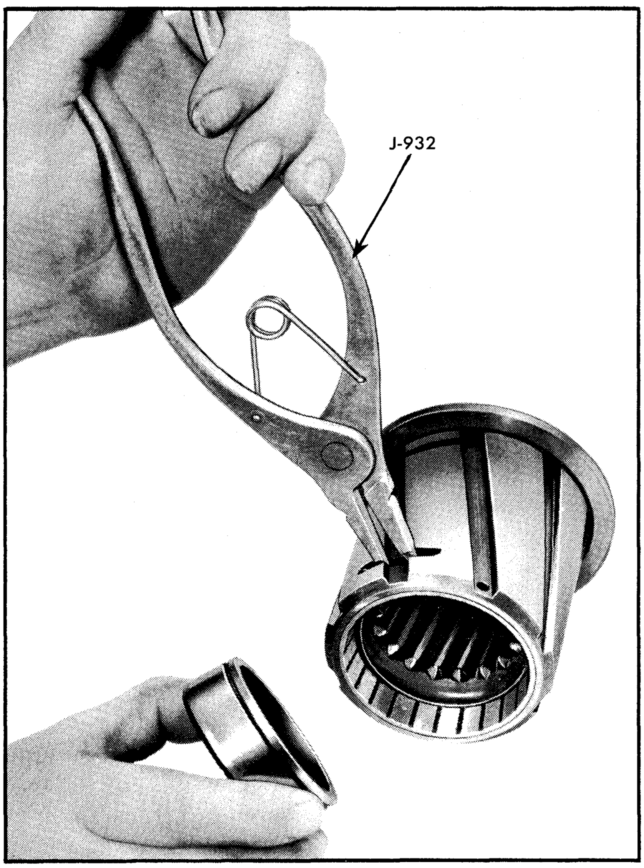



Fig. 7-25 Removing or Installing Synchronizer Ring

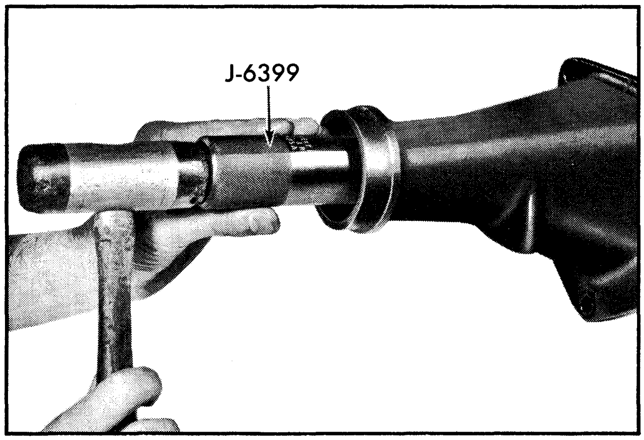



Fig. 7-26 Removing or Installing Bushing with J-6399

1. After cleaning bearings, lubricate them with light engine oil and check for roughness. Roughness may be determined by turning the outer race by hand.

GEARS

1. Inspect teeth of all gears for nicks or wear and, if necessary, replace any that are worn or damaged.

2. Check first and reverse sliding gear, making certain it slides freely on second and third speed clutch.

3. Check second and third speed clutch, making certain it slides freely on mainshaft.

REVERSE IDLER GEAR SHAFT, BUSHINGS, THRUST WASHERS AND BEARING; AND NEEDLE BEARING ROLLERS

1. Check reverse idler gear shaft for excessive wear and, if wear or damage is indicated, it should be replaced.

2. The bushings used in the reverse idler gear are pressed into the gear, then peened into holes in the bores to lock them in place. They are accurately bored with special diamond boring tools to insure positive alignment of the bushings and the shaft, as well as to insure proper meshing of the gears. Because of the high degree of accuracy to which these parts are machined, the bushings are never serviced separately.

3. Check bushings for excessive wear by inserting a narrow feeler gauge between the shaft and the bushing. The proper clearance is from .002" to .004".

4. The thrust washers and radial roller thrust bearing should be closely examined for wear or damage and replaced if wear or damage is indicated.

5. The 50 countergear needle bearing rollers should be closely inspected for excessive wear and replaced if worn.

6. Closely inspect the 14 front and 24 rear mainshaft pilot needle bearing rollers and replace if worn.

CLUTCH (SLEEVE) SYNCHRONIZER RINGS AND CONES

1. Check synchronizer cones for wear or for looseness in clutch sleeve. If cones are damaged in any way, it will be necessary to replace entire clutch assembly and both synchronizer rings.

2. Inspect synchronizer rings for smoothness.

3. Place synchronizer rings in synchronizer cones and apply pressure with thumbs to see that rings do not rock. Excessive rocking indicates a poor fit between rings and cones and prevents proper synchronizing of gears during shifting.

### *INTERNAL COMPONENTS—ASSEMBLE*

TRANSMISSION CASE EXTENSION BUSHING AND OIL SEAL - REPLACE

1. Using tool J-6399, drive bushing, from rear of transmission, until end of bushing is slightly below counterbore for oil seal (Fig. 7-26). Coat I.D. of bushing with transmission oil.

2. To replace oil seal, coat new seal with sealing compound and start straight in bore of case extension. Using installer J-5154-A, tap seal into counterbore (Fig. 7-13).

SYNCHRONIZER ENERGIZING SPRINGS - REPLACE

1. One end of each spring is slightly offset. Each spring must be assembled in its groove in main drive (clutch) gear and second speed gear with offset, or locking end, between third and fourth tooth from either end of either of two banks of teeth on these gears. This prevents the spring from turning in its groove (Fig. 7-27).

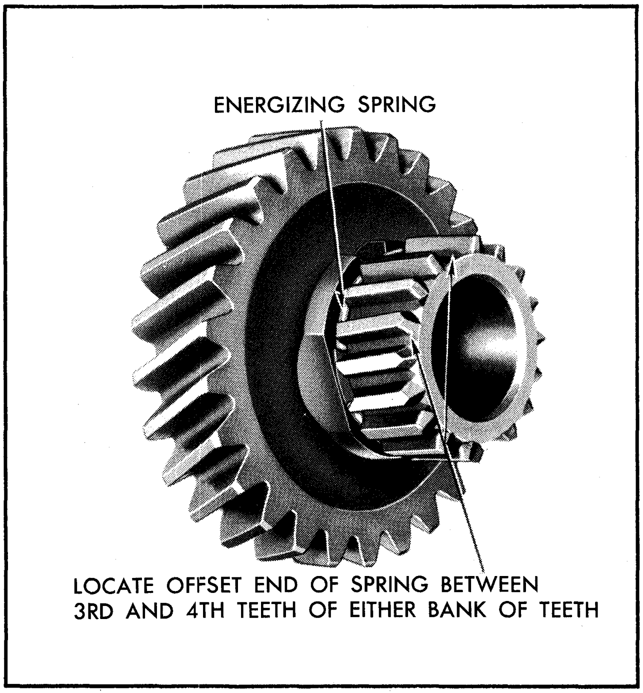



Fig. 7-27 Position of Synchronizer Ring Energizing Spring

*NOTE: In replacing energizing springs, be careful not to distort the springs by expanding them too much when sliding them over the clutch teeth of main drive (clutch) gear and second speed gear.*

CLUTCH (SLEEVE) AND SYNCHRONIZER RINGS - ASSEMBLE

1. Lubricate both synchronizer rings with light grease as an aid in preventing synchronizer ring "lock-up".

2. Install a synchronizer ring retainer (snap ring) in counterbore at one end of clutch sleeve.

3. Insert tool J-932 through slot in clutch sleeve (Fig. 7-25), and expand retainer in counterbore. Install synchronizer ring in clutch sleeve.

4. Install other synchronizer ring in same manner.

*NOTE: Make certain retainers seat fully in their grooves around the rings so rings will turn freely.*

MAIN DRIVE (CLUTCH) GEAR - ASSEMBLE

1. Using an arbor press, press main drive (clutch) gear bearing on main drive (clutch) gear shaft, making certain locating ring groove is toward the front of shaft.

2. Install combination clutch bearing retaining nut and oil slinger on main drive (clutch) gear shaft (Fig. 7-23), drawing it up tightly with tool J-933.

3. Lock retaining nut and oil slinger in place by staking it into flat on shaft with center punch. Use extreme care so as not to damage threads on shaft.

*CAUTION: The main drive (clutch) gear bearing must turn as freely after installation on shaft as it turned before being installed.*

MAINSHAFT ASSEMBLY - ASSEMBLE

1. Slide second speed gear on mainshaft, clutch hub to front.

2. Install thrust washer with oil grooves toward gear.

3. Press rear bearing on mainshaft, making certain groove in O.D. of bearing is toward second speed gear.

*NOTE: Check position of bearing snap ring groove before installing bearing on mainshaft. Bearing must seat forward of this groove with minimum amount of end play.*

4. Select one of four available snap rings so end play of bearing on shaft does not exceed .004". This may be easily determined by trying successively larger rings and selecting the thickest ring that will enter snap ring groove on shaft.

5. Start speedometer drive gear on shaft with chamfered I.D. of gear toward bearing. Press gear on shaft until rear face of gear is 1 7/16" from rear face of bearing (Fig. 7-28).

6. Install special snap ring on end of mainshaft.

***TRANSMISSION—ASSEMBLE***

REVERSE IDLER GEAR

1. Coat thrust washers and radial roller thrust bearing with grease.

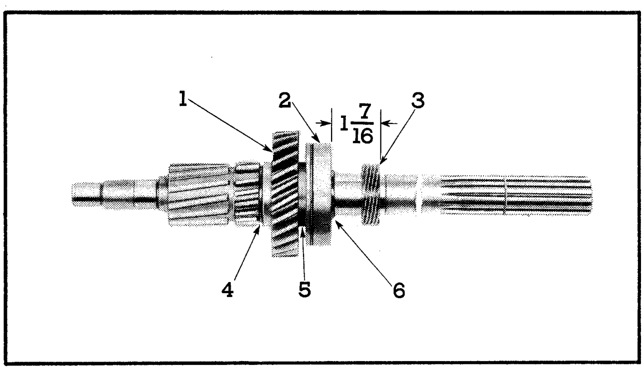
2. Position radial roller thrust bearing against rear of gear (end with chamfered gear teeth) and position large thrust washer against bearing. Position small thrust washer at opposite (front end) of gear (Fig. 7-29).

3. From rear of case, install idler shaft, aligning lock pin hole in shaft with hole in case (Fig. 7-30). and tap shaft in until front of shaft is flush with inner side of rear boss.

4. Position reverse idler gear assembly in case so radial roller thrust bearing is toward rear of case and gear is lined up with shaft. With soft hammer, tap shaft from rear until lock pin holes are lined up.

5. Coat new idler shaft lock pin with sealer and drive it in approximately 1/16" beyond flush with case. Peen hole slightly to ensure lock pin is secure and to prevent oil leak.

6. Install new idler shaft expansion plug in front of case.




1. Second Speed Gear
2. Rear Bearing
3. Speedometer Drive Gear
4. Energizing Spring
5. Thrust Washer
6. Snap Ring

Fig. 7-28 Mainshaft Assembly

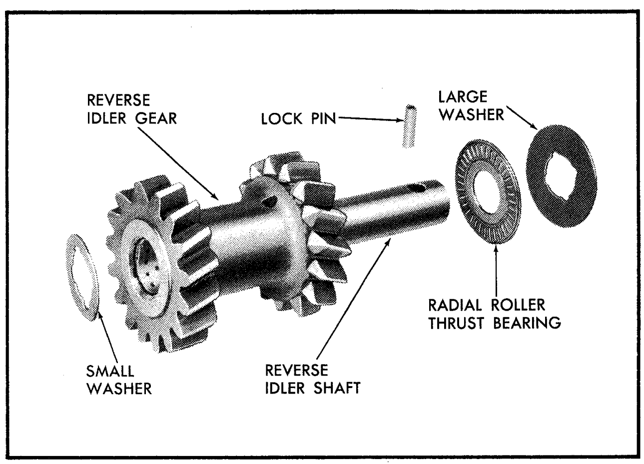



Fig. 7-29 Reverse Idler Gear, Shaft and Thrust Washers

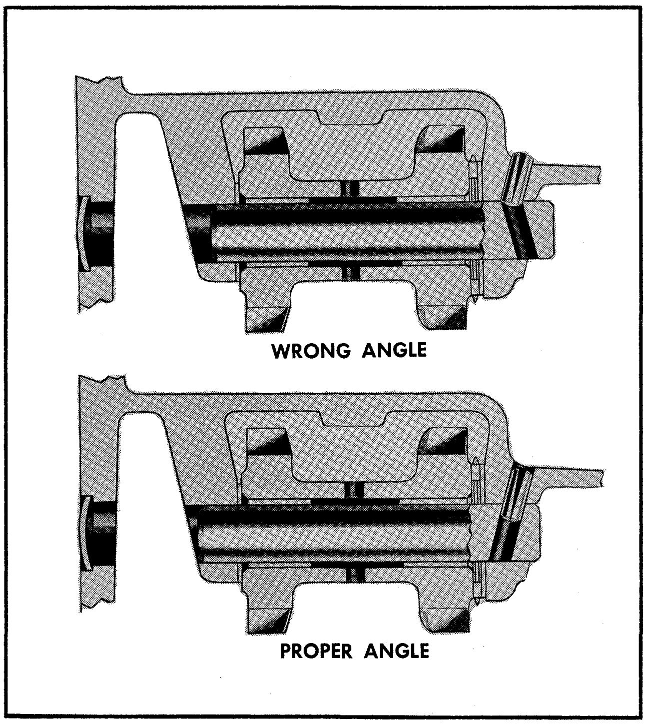



Fig. 7-30 Reverse Idler Gear Shaft and Lock Pin

COUNTERGEAR AND MAIN DRIVE (CLUTCH) GEAR

1. Apply cup grease in roller bearing area at each end of countergear and insert tool J-5777 in countergear.

2. Install 25 roller bearings, around tool J-5777, at each end of countergear. The grease will hold bearings in place while installing countergear assembly in case.

3. Apply grease to bearing thrust washers and countergear thrust washers and place bearing thrust washers, followed by countergear thrust washers, at both ends of countergear (Fig. 7-31), making certain tangs on countergear thrust washers face out.

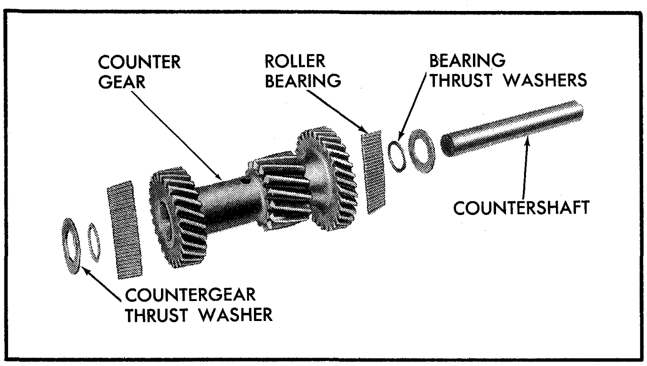



Fig. 7-31 Countergear Assembly

4. With tool J-5777 in position, place countergear in rear of transmission case, large gear first, and rest it on bottom of case.

5. From inside case, push main drive (clutch) gear assembly through opening in front face of case and, using a brass drift, tap the clutch gear assembly until the clutch gear bearing locating ring groove is outside front of case. Assembly must be driven straight to prevent damage to bearing (Fig. 7-32).

6. Install snap ring in bearing groove and tap main drive (clutch) gear toward the rear until snap ring rests firmly against face of case.

7. Install main drive (clutch) gear bearing retainer and new retainer gasket. Gasket must not protrude beyond edge of retainer.

*NOTE: The holes in the retainer are unevenly spaced so that retainer can be assembled to case in only one position, matching up oil return slot with oil outlet hole in case.*

8. Apply sealing compound to threads of four retainer to case bolts and install bolts and special lockwashers. Torque 12 to 15 lb. ft.

9. Turn transmission case on flat, or top side.

10. Lower countergear so that idler gear, main drive (clutch) gear and countergears mesh properly. Be careful that thrust washers at end of countergear are not dislodged.

11. Lubricate and start countershaft in case from rear, making certain that flat on end of shaft is horizontal and toward bottom of case.

*NOTE: Flat on shaft must be horizontal and at bottom to permit installation of case extension.*

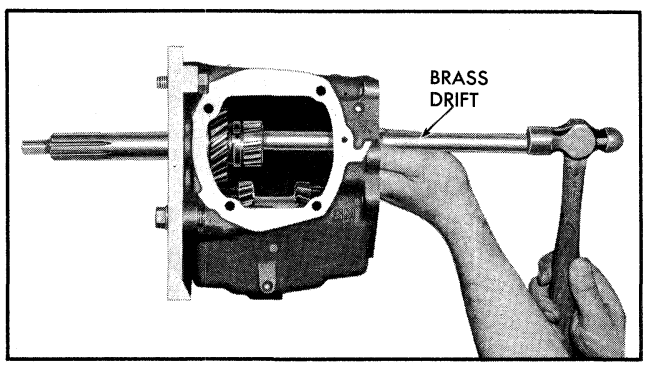



Fig. 7-32 Installation of Main Drive (Clutch) Gear Assembly

12. Align countergear with shaft and, using soft hammer, tap shaft through, pushing bearing loader J-5777 out front of case (Fig. 7-33).

13. Continue to tap shaft until flat on end is flush with rear face of case.

14. Apply cup grease to pilot hole in main drive (clutch) gear to retain pilot bearing rollers (Fig. 7-34).

15. Install the 14 larger rollers and then insert small I.D. spacer.

16. Insert the large I.D. front spacer, followed by the 24 smaller rollers.

SYNCHRONIZING CLUTCH SLEEVE - FIRST AND REVERSE SLIDING GEAR

1. Assemble first and reverse gear on the clutch assembly.

2. Insert both pieces into the side opening of the case by tipping the front end of the assembly into the opening first.

3. Align the lug of the synchronizing ring with the synchronizing slot of the clutch gear and position the assembly on gear to receive the mainshaft.

MAINSHAFT AND EXTENSION

1. Position snap ring in extension and carefully insert mainshaft assembly in transmission case extension. Using tool J-932, spread mainshaft bearing

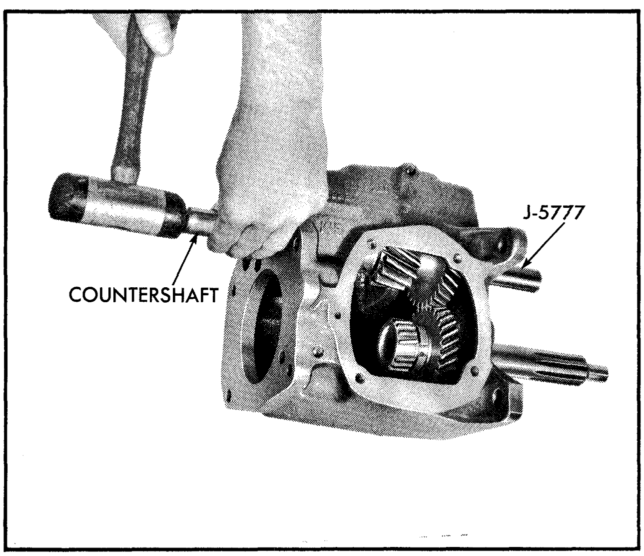



Fig. 7-33 Installation of Countershaft

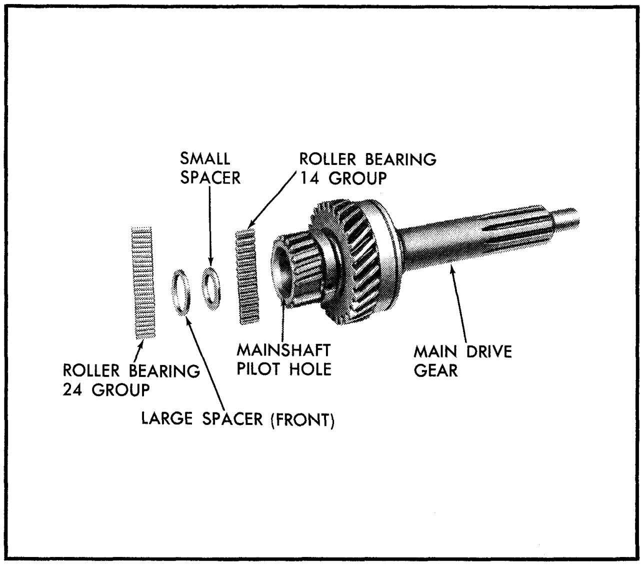



Fig. 7-34 Main Drive (Clutch) Gear Assembly

snap ring and tap front end of mainshaft, using soft hammer, until snap ring seats firmly in mainshaft bearing groove.

2. Affix new extension housing gasket to transmission case.

3. Align clutch splines on mainshaft with clutch splines on second speed gear so as to receive the two inner lugs of synchronizing ring of second and third speed clutch. Mark for identification (Fig. 7-35).

4. Lower mainshaft assembly through opening at rear of transmission case, making certain two inner

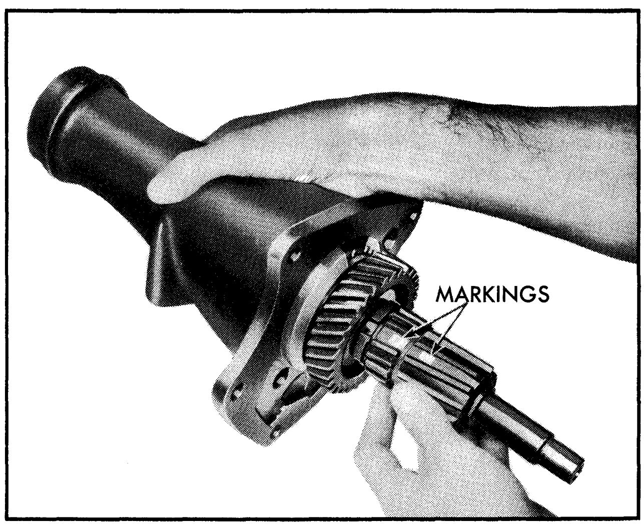



Fig. 7-35 Alignment of Synchronizer Clutch Splines on Mainshaft and Second Speed Gear

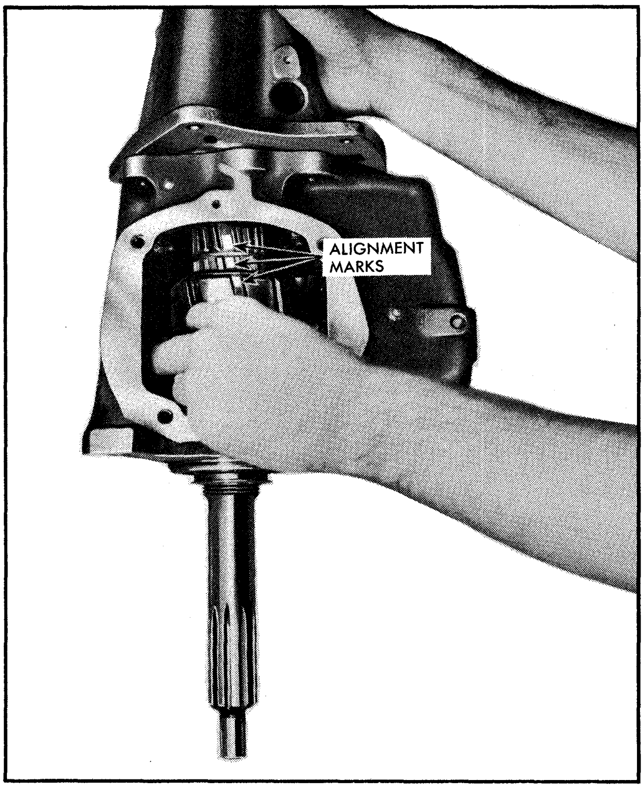



Fig. 7-36 Installing Mainshaft in Transmission Case

lugs of synchronizing ring engage previously marked grooves of mainshaft and second speed gear (Fig. 7-36).

*CAUTION: Use extreme care when lowering mainshaft assembly into transmission case to prevent roller bearings from falling into mainshaft pilot hole. Sudden weight exerted on synchronizing rings may cause them to lock up.*

5. Rotate extension housing to line up with case, insert the five extension housing to case bolts and washers, (apply special sealing compound to threads of bottom attaching bolt) and finger tighten.

6. Set transmission assembly, top side up, on bench. Maneuver second and third speed clutch until extension housing fits flush against transmission case. Tighten bolts 40 to 45 lb. ft. torque.

7. Install speedometer driven gear and fitting in extension housing as outlined under SPEEDOMETER DRIVEN GEAR - REPLACE, steps 1 through 5.

8. Install side cover as outlined under TRANSMISSION SIDE COVER - ASSEMBLE AND INSTALL.

9. Install clamp, bracket and insulator assembly on rear extension.

## TRANSMISSION—INSTALL IN VEHICLE

1. Raise transmission until rear extension can be moved rearwards over center cross member.

2. Move transmission forward, aligning with rear of clutch housing and lower rear extension until bracket studs engage holes in cross member support.

3. Insert aligning studs J-1126 in upper transmission to clutch housing bolt holes.

4. Install two lower transmission to clutch housing bolts and tighten 45-60 lb. ft. torque.

5. Remove aligning studs and install two upper transmission to clutch housing bolts and tighten 45-60 lb. ft. torque.

6. Install transmission extension to cross member insulator. Tighten bolts to 25-35 lb. ft. torque. (See Fig. 6-14, 6 cyl., Fig. 6-94, 8 cyl.)

7. Connect shift linkage. (See gearshift Linkage Adjustment pg. 7-6).

*NOTE: If car is equipped with gearshift control on the floor, also install lever and bracket assembly to side of transmission extension. Tighten bolts to 20-35 lb. ft. torque and nut 45-55 lb. ft. torque.*

8. Connect speedometer cable to speedometer driven gear fitting.

9. Install propeller shaft drive line assembly by reversing steps a. through c. under TRANSMISSION - REMOVE FROM VEHICLE.

10. Remove filler plug at side of transmission and add 1.8 pints of SAE 90 "Multi-purpose Gear Lubricant". Lubricant level should be approximately level with bottom of filler plug hole. Install plug.

11. Check complete shift pattern and adjust as required.

## TROUBLE DIAGNOSIS AND TESTING

| TROUBLE | REMEDY |
|---|---|
| **SLIPS OUT OF HIGH GEAR** | |
| a. Transmission loose on clutch housing. | a. Tighten mounting bolts. |
| b. Shift rods interfere with engine mounts or clutch throw-out lever. | b. Replace or bend levers and rods to eliminate interference. |
| c. Shifter linkage does not work freely, binds. | c. Adjust and free up shift linkage. Torque reactions of engine should not cause the lever on transmission to move. The movement of transmission with respect to body and frame should be transferred to the control linkage. |
| d. Does not fully engage. | d. Measure length of engagement pattern on clutching teeth. If less than 7/64", check for bent levers, shifter shafts, detent cam plates, control rods and other shift linkage. Replace or straighten defective parts. |
| e. Damaged mainshaft pilot bearing. | e. Replace pilot bearing. |
| f. Main drive (clutch) gear bearing retainer broken or loose. | f. Tighten or replace main drive (clutch) gear bearing retainer. |
| g. Dirt between transmission case and clutch housing. | g. Clean mating surfaces. |
| h. Misalignment of transmission. | h. Shim between transmission case and clutch housing. |
| **NOISY IN ALL GEARS** | |
| a. Insufficient lubricant. | a. Fill to correct level. |
| b. Worn countergear bearings. | b. Replace countergear bearings and shaft. |
| c. Worn or damaged main drive (clutch) gear and countergear. | c. Replace worn or damaged gears. |
| d. Damaged main drive (clutch) gear or mainshaft ball bearings. | d. Replace damaged bearings. |
| e. Damaged speedometer gears. | e. Replace damaged gears. |
| **NOISY IN HIGH GEAR** | |
| a. Damaged main drive (clutch) gear bearing. | a. Replace damaged bearing. |
| b. Damaged mainshaft bearing. | b. Replace damaged bearing. |
| c. Damaged speedometer gears. | c. Replace speedometer gears. |

| | |
|---|---|
| **NOISY IN NEUTRAL WITH ENGINE RUNNING** | |
| a. Damaged main drive (clutch) gear bearing. | a. Replace damaged bearing. |
| b. Damaged mainshaft bearing. | b. Replace damaged bearing. |
| **NOISY IN ALL REDUCTION GEARS** | |
| a. Insufficient lubricant. | a. Fill to correct level. |
| b. Worn or damaged clutch gear or countergear. | b. Replace faulty or damaged gears. |
| **NOISY IN SECOND ONLY** | |
| a. Damaged or worn second speed constant mesh gears. | a. Replace damaged gears. |
| b. Worn or damaged countergear rear bearings. | b. Replace countergear bearings and shaft. |
| **NOISY IN LOW AND REVERSE ONLY** | |
| a. Worn or damaged first and reverse sliding gear. | a. Replace worn gear. |
| b. Damaged or worn low and reverse countergear. | b. Replace countergear assembly. |
| **NOISY IN REVERSE ONLY** | |
| a. Worn or damaged reverse idler gear. | a. Replace reverse idler gear assembly. |
| b. Worn reverse idler bushings. | b. Replace reverse idler gear assembly. |
| c. Damaged or worn reverse countergear. | c. Replace countergear assembly. |
| **EXCESSIVE BACKLASH IN SECOND ONLY** | |
| a. Second speed gear thrust washer worn. | a. Replace thrust washer. |
| b. Mainshaft rear bearing not properly installed in case. | b. Replace bearing, lock or case as necessary. |
| c. Universal joint retaining bolt loose. | c. Tighten bolt. |
| d. Worn countergear rear bearing. | d. Replace countergear bearings and shaft. |
| **EXCESSIVE BACKLASH IN ALL REDUCTION GEARS** | |
| a. Worn countergear bushings. | a. Replace countergear. |
| b. Excessive end play in countergear. | b. Replace countergear thrust washers. |

LEAKS LUBRICANT

| | |
|---|---|
| a. Excessive amount of lubricant in transmission. | a. Drain to correct level. |
| b. Loose or broken main drive (clutch) gear bearing retainer. | b. Tighten or replace retainer. |
| c. Main drive (clutch) gear bearing retainer gasket damaged. | c. Replace gasket. |
| d. Cover loose or gasket damaged. | d. Tighten cover or replace gasket. |
| e. Operating shaft seal leaks. | e. Replace operating shaft seal. |
| f. Idler shaft expansion plugs loose. | f. Replace expansion plugs. |
| g. Countershaft loose in case. | g. Replace case. |

## TRANSMISSION SPECIFICATIONS

The transmission face, clutch housing and block are accurately squared in production so that each unit may be interchanged as necessary. Special alignment of these assemblies is not necessary if they are installed properly.

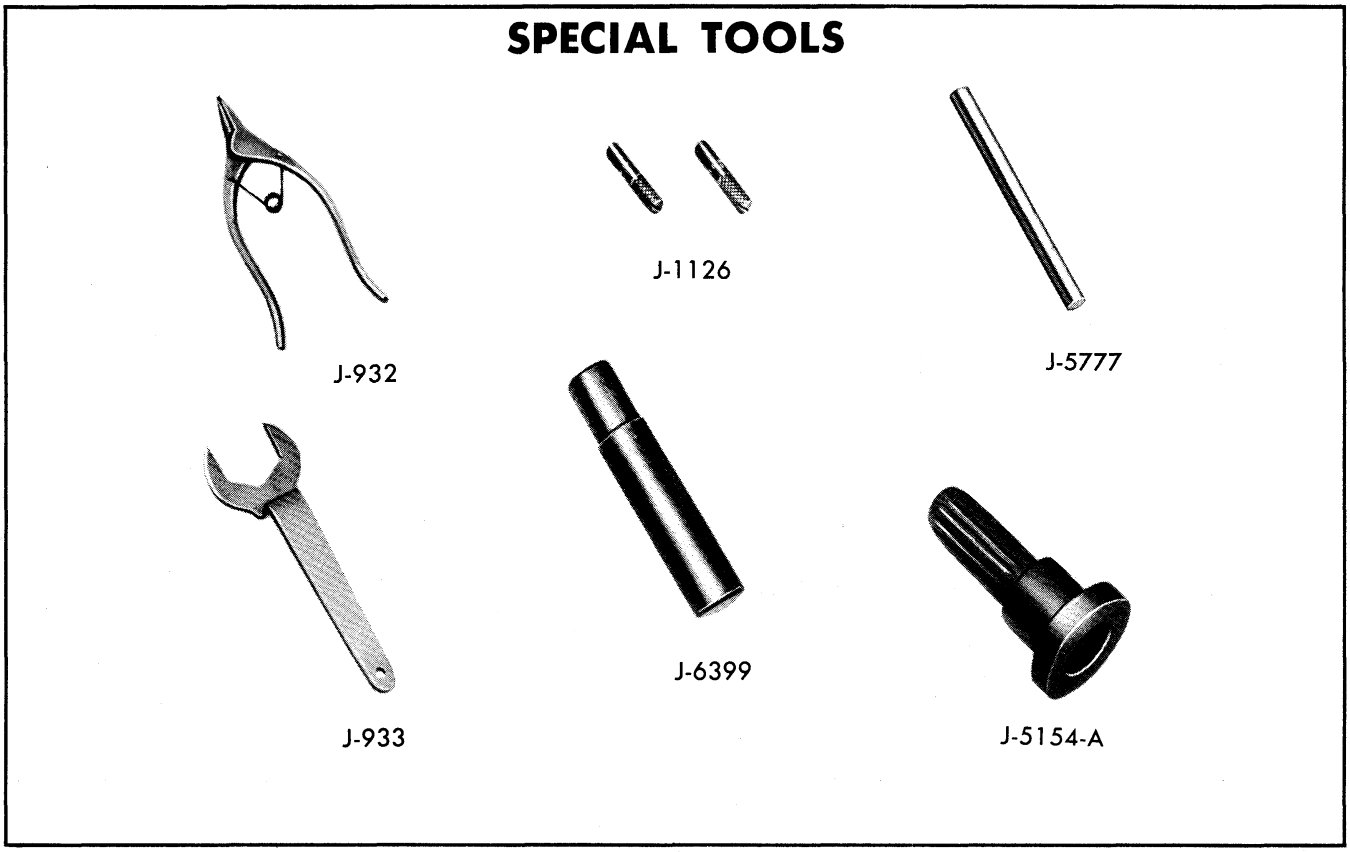
| Shift Positions | Gear Ratios 6 Cyl. | Gear Ratios 8 Cyl. |
|---|---|---|
| Low | 2.94 | 2.58 |
| Second | 1.68 | 1.48 |
| Third | 1.1 | 1.1 |
| Reverse | 2.94 | 2.58 |

Lubricant Capacity . . . . . . . . . . . . . . . . . . . . . . . . . . 1.8 Pints

## TORQUE SPECIFICATIONS

| | Lb. Ft. |
|---|---|
| Transmission Drain Plug | 25-35 |
| Transmission Filler Plug | 25-35 |
| Rear Extension Bolts | 40-45 |
| Side Cover Bolts | 15-18 |
| Clutch Gear Bearing Retainer Bolts | 12-15 |
| Transmission to Flywheel Housing | 45-60 |
| Transmission Shifter Lever to Shaft Nuts | 10-20 |
| Transmission Control Lever to 1st and Reverse Shift Rod Nut | 8-12 |
| Transmission Control Lever to 2nd and 3rd Shift Rod Nut | 8-12 |
| Transmission Control Lever and Bracket Assembly to Support Nut | 45-55 |
| Transmission Control Lever and Bracket Assembly to Transmission Extension Bolt | 20-35 |
| Transmission Control Lever and Bracket Support to Transmission Extension Bolt | 20-35 |
| Transmission Support Mount Assembly to Crossmember | 25-35 |

| | Lb. In. |
|---|---|
| Speedometer Driven Gear Retainer to Transmission Screw and Lockwasher | 35-60 |
| Speedometer Cable to Driven Gear Nut | 40-50 |




| | |
|---|---|
| J-932 | Snap Ring Pliers |
| J-933 | Clutch Gear Retainer Nut Wrench |
| J-1126 | Aligning Studs |
| J-5154-A | Transmission Extension Oil Seal Installer |
| J-5777 | Countershaft Bearing Loader |
| J-6399 | Rear Bearing Extension Bushing - Remove and Replace |

Fig. 7-37 Synchromesh Transmission Special Tools

# FOUR-SPEED TRANSMISSION AND SHIFT LINKAGE

## CONTENTS OF THIS SECTION



## DESCRIPTION

The four-speed synchromesh transmission (Fig. 7A-1) is available only on special order and is engineered to operate on all Tempest models. It consists of two basic sections; the transmission case, or forward section, and the case extension, or rear section. The forward section contains the four forward speed gear assemblies, clutch assemblies and synchronizing mechanisms, while the rear section contains the reverse gear assembly.

Gearshifting is manual through a floor-type gearshift lever which activates shift control rods connected to the transmission cover shifter levers for first through fourth gears, and to the reverse lever located in the case extension. The shifter lever to the rear of the transmission cover controls the first and second speed gears, while the lever to the front controls the third and fourth speed gears.

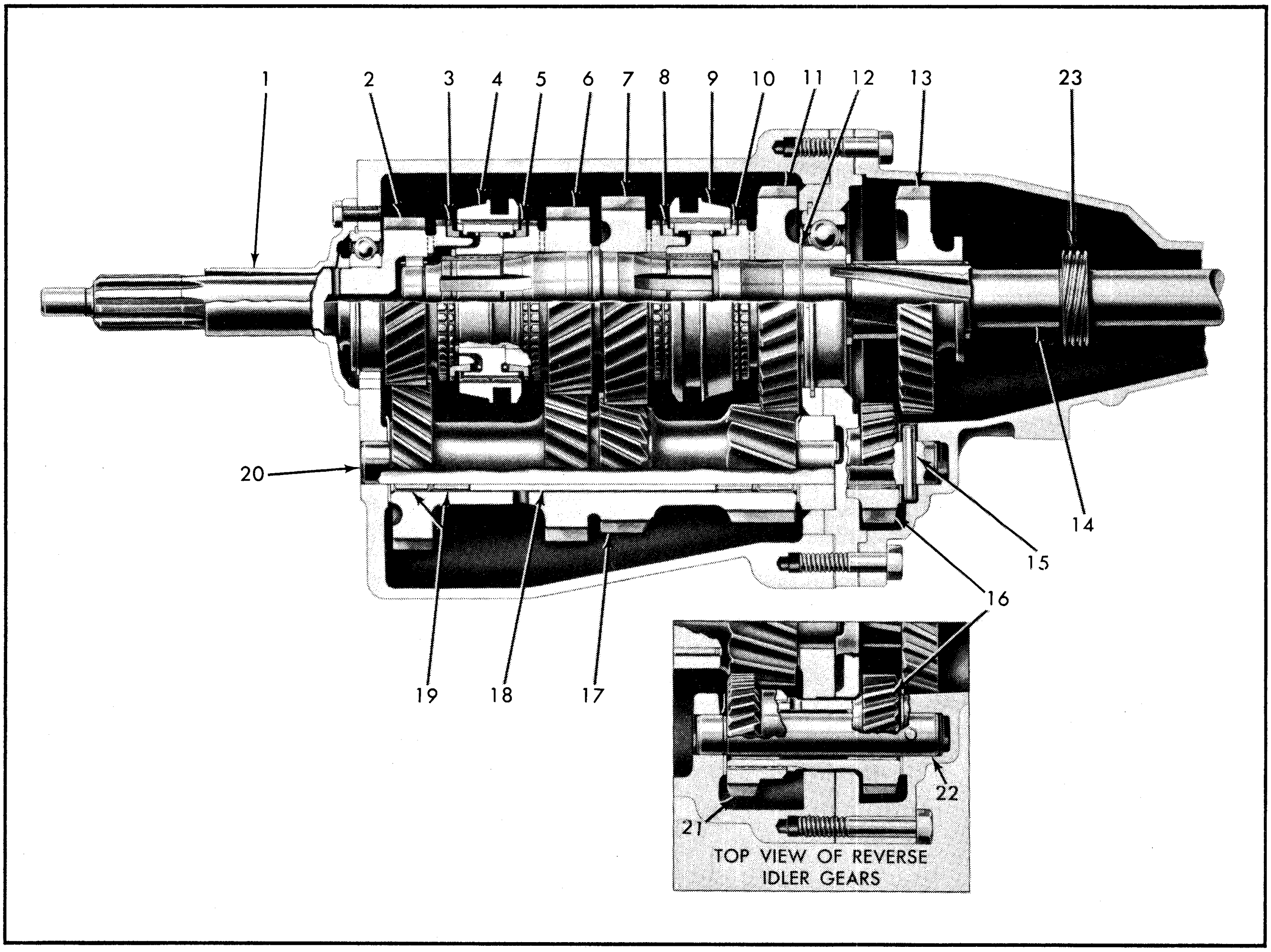
All four forward gears are provided with synchronizing clutches which can be engaged while the car is in motion (Fig. 7A-1). Closely spaced gear ratios of 2.56 (first), 1.91 (second), 1.48 (third) and 1.00 (fourth) provide excellent ratio matching with minimum loss of engine speed at the shift points. Reverse gear (2.64 ratio) is not synchronized; therefore, vehicle should be brought to a complete stop before engaging reverse gear.

The transmission may be used as an aid in decelerating by downshifting in sequence without double clutching or gear clashing due to all forward speeds being synchronized.

## DESIGN

The four-speed transmission incorporates helical gears specially designed to provide high torque capacity without additional weight, and gear teeth proportioned to operate at high speeds with neither excessive heat generation nor excessive frictional losses. Shafts, bearings, high capacity clutches and other precision parts are held to close limits, providing proper clearances necessary for durability during extended heavy usage.

Seven basic gears are utilized in this transmission. They are: main drive gear, third speed gear, second speed gear, first speed gear, reverse gear, countergear and reverse idler gear (front and rear). See Fig. 7A-1.




1. Bearing Retainer
2. Main Drive Gear
3. Fourth Speed Synchronizing Ring
4. Third and Fourth Speed Clutch Assembly
5. Third Speed Synchronizing Ring
6. Third Speed Gear
7. Second Speed Gear
8. Second Speed Synchronizing Ring
9. First and Second Speed Clutch Assembly
10. First Speed Synchronizing Ring
11. First Speed Gear
12. Thrust Washer
13. Reverse Gear
14. Mainshaft
15. Reverse Idler Shaft Roll Pin
16. Reverse Idler Gear (Rear)
17. Countergear
18. Countergear Bearing Roller Spacer
19. Countergear Bearing Roller
20. Countershaft
21. Reverse Idler (Gear) (Front)
22. Reverse Idler Shaft
23. Speedometer Drive Gear

Fig. 7A-1 Cross Section of Four-Speed Synchromesh Transmission

The front end of the main drive gear is piloted in a single row, prepacked and shielded ball bearing mounted in the engine crankcase, while the rear end is supported by a heavy duty ball bearing located at the front end of the transmission case.

The front end of mainshaft is piloted in a row of roller bearings set into the hollow end of the main drive gear and the rear end is carried by a heavy duty ball bearing located at the rear end of the transmission case.

The countergear is carried on a double row of roller bearings positioned at both ends of the gear, while thrust is taken on thrust washers located at front and rear of gear.

The two-piece reverse idler gear is carried on press-fit bronze bushings and thrust is taken on thrust washers located between the front of the gear and the back of the reverse idler thrust boss and the rear of the gear and the reverse idler shaft boss in the case extension.

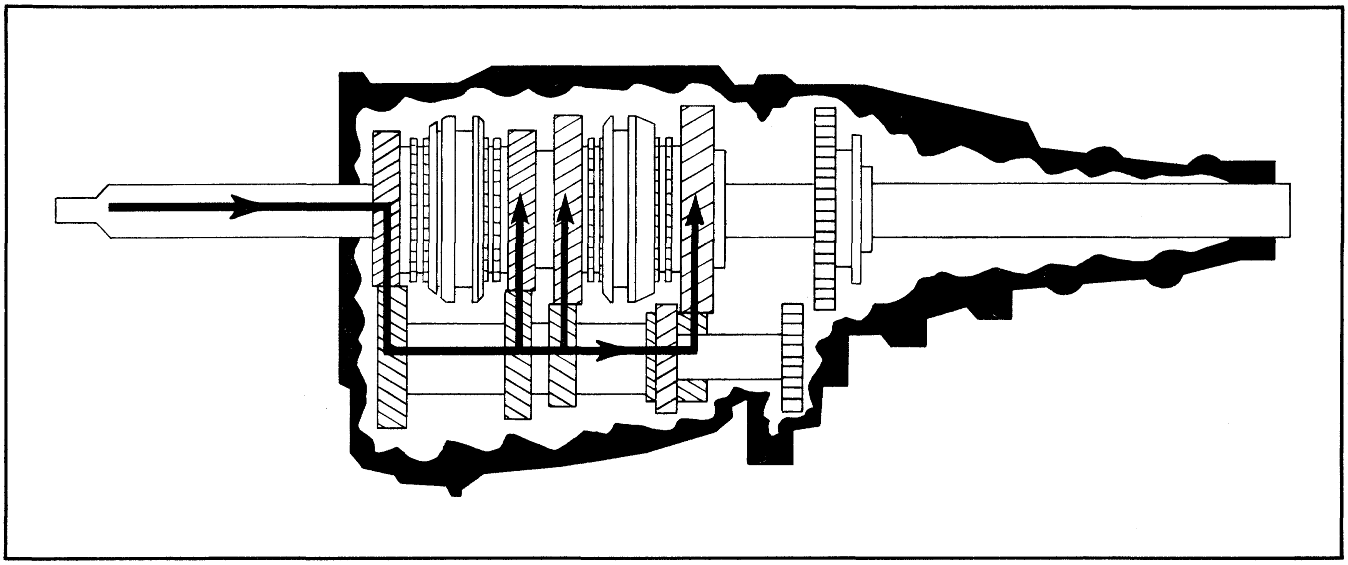


Fig. 7A-2 Four-Speed Synchromesh - Power Flow in Neutral

The first, second and third speed gears have press-fit bushings lining their inner bores which enable these gears to float freely on the mainshaft, while the reverse speed gear has splines on its inner bore to prevent the gear from rotating on the mainshaft but allow forward and rearward movement of this gear.

The two clutch assemblies are splined to the mainshaft so that they can impart torque to the mainshaft whenever they engage a rotating gear.

## OPERATION

The main drive gear, third speed gear, second speed gear, first speed gear and reverse idler gears are in constant mesh with the countergear; therefore, with the engine running and the engine clutch engaged, torque is imparted to the main drive gear and through the countergear to the third, second, first, and reverse idler at all times.

### *OPERATION IN NEUTRAL (Fig. 7A-2)*

In neutral, with engine clutch engaged, the main drive gear turns the countergear. The countergear then turns the third, second, first, and reverse idler gears. But, because the third and fourth and first and second speed clutch (sleeves) are neutrally positioned, and the reverse speed gear is positioned at the rear, away from the reverse idler gear, power will not flow through the mainshaft.

### *OPERATION IN FIRST (Fig. 7A-3)*

In first speed, the first and second speed clutch (sleeve) is moved rearwards to engage the first speed gear, which is being turned by the countergear. Because the first and second speed clutch (hub) is splined to the mainshaft, torque is imparted to the mainshaft from the first speed gear through the clutch assembly.

### *OPERATION IN SECOND (Fig. 7A-4)*

In second speed, the first and second speed clutch (sleeve) is moved forward to engage the second speed gear, which is being turned by the countergear. This engagement of the clutch (sleeve) with the second speed gear imparts torque to the mainshaft because the first and second speed clutch (hub) is splined to the mainshaft.

### *OPERATION IN THIRD (Fig. 7A-5)*

In third speed, the first and second speed clutch assumes a neutral position. The third and fourth speed clutch (sleeve) moves rearward to engage the third speed gear, which is being turned by the countergear. Because the third and fourth speed clutch (hub) is splined to the mainshaft, torque is

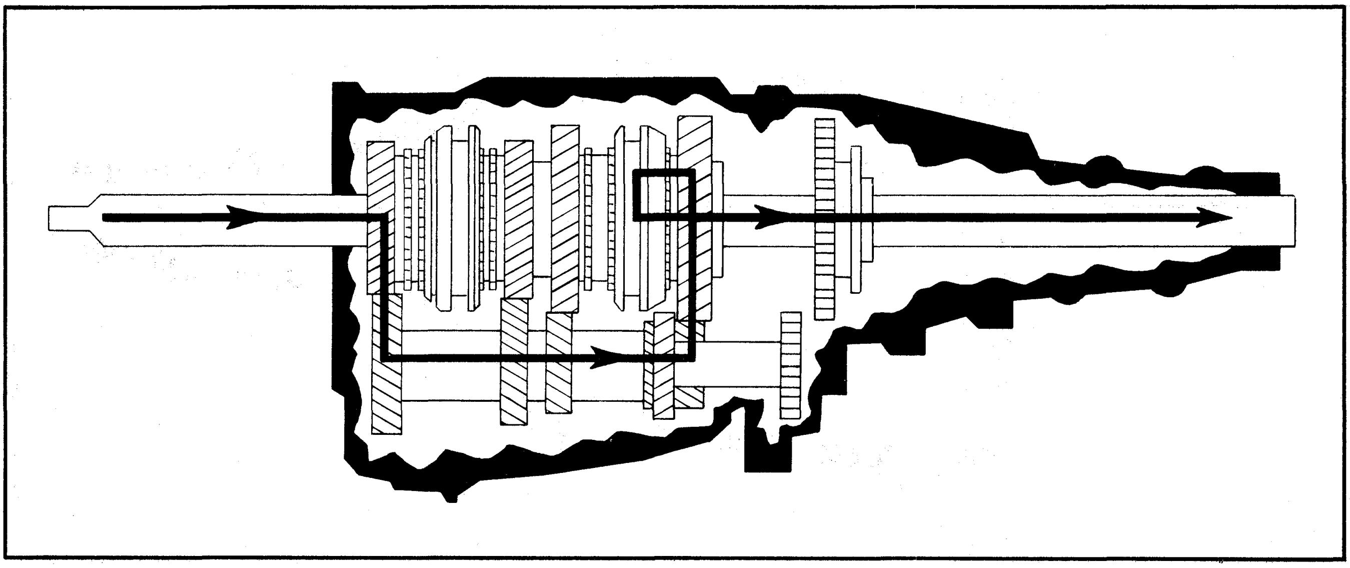


Fig. 7A-3 Four-Speed Synchromesh - Power Flow in First

imparted to the mainshaft from the third speed gear through the clutch assembly.

### *OPERATION IN FOURTH (Fig. 7A-6)*

In fourth speed, or direct drive, the third and fourth speed clutch (sleeve) is moved forward to engage the main drive gear and the first and second speed clutch remains in a neutral position. This engagement of the main drive gear with the third and fourth speed clutch assembly imparts torque directly to the mainshaft.

### *OPERATION IN REVERSE (Fig. 7A-7)*

In reverse speed, both clutch assemblies assume a neutral position. The reverse speed gear is moved forward to engage the rear reverse idler gear, which is being turned by the countergear. Because the reverse speed gear is splined to the mainshaft, this engagement causes the mainshaft to turn; however, because power flows from main drive gear to countergear and through reverse idler gear to reverse speed gear, the direction of rotation will be opposite that of the engine.

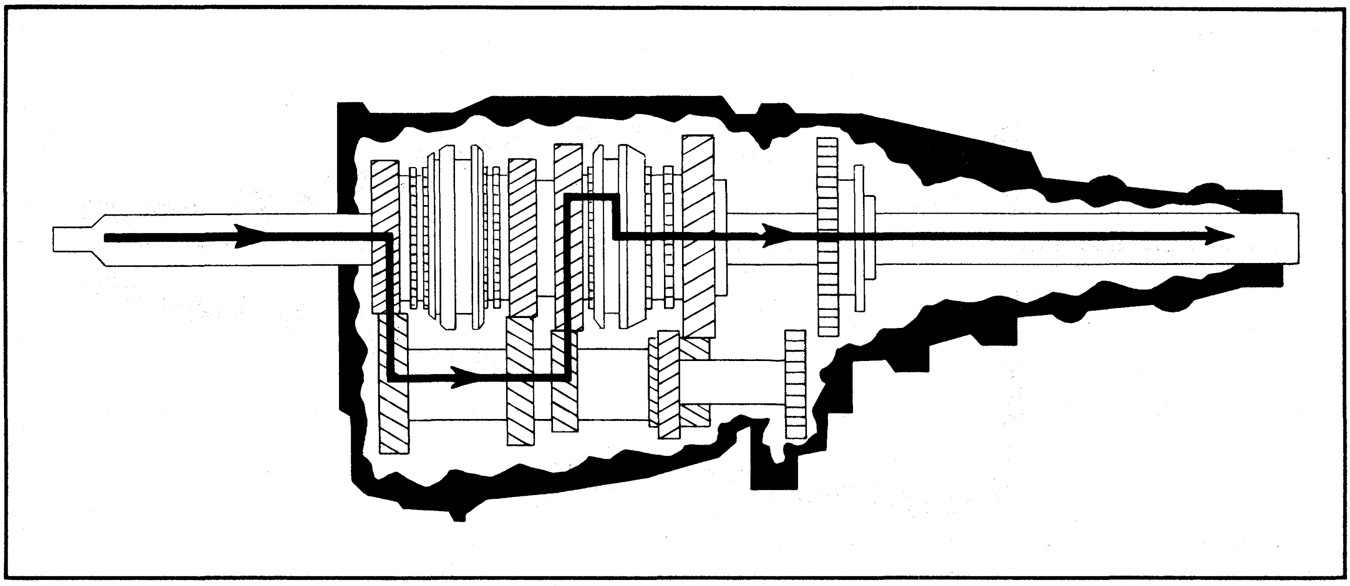


Fig. 7A-4 Four-Speed Synchromesh - Power Flow in Second Speed

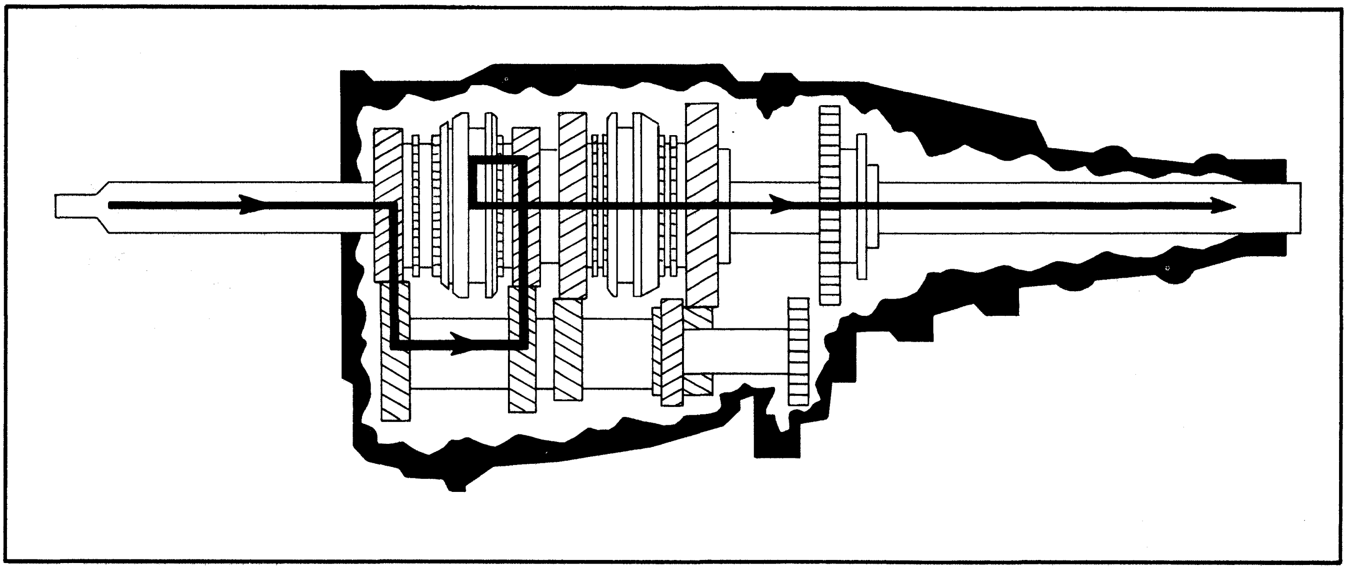


Fig. 7A-5 Four-Speed Synchromesh - Power Flow in Third Speed

## PERIODIC SERVICE

### *TRANSMISSION*

No periodic service of the transmission is required except checking for leaks and proper lubricant level every 60 days.

If there is evidence of leakage, the leak should be corrected and lubricant added, if needed. Refill capacity is 2.5 pints.

Remove filler plug at side of case and add SAE 90 "Multi-purpose Gear Lubricant". Lubricant level should be approximately level with bottom of filler plug hole. Install plug.

### *SHIFT CONTROL*

No periodic service of the shift control is required. Certain parts are lubricated on assembly and require further lubrication only when parts become dry and sticky.

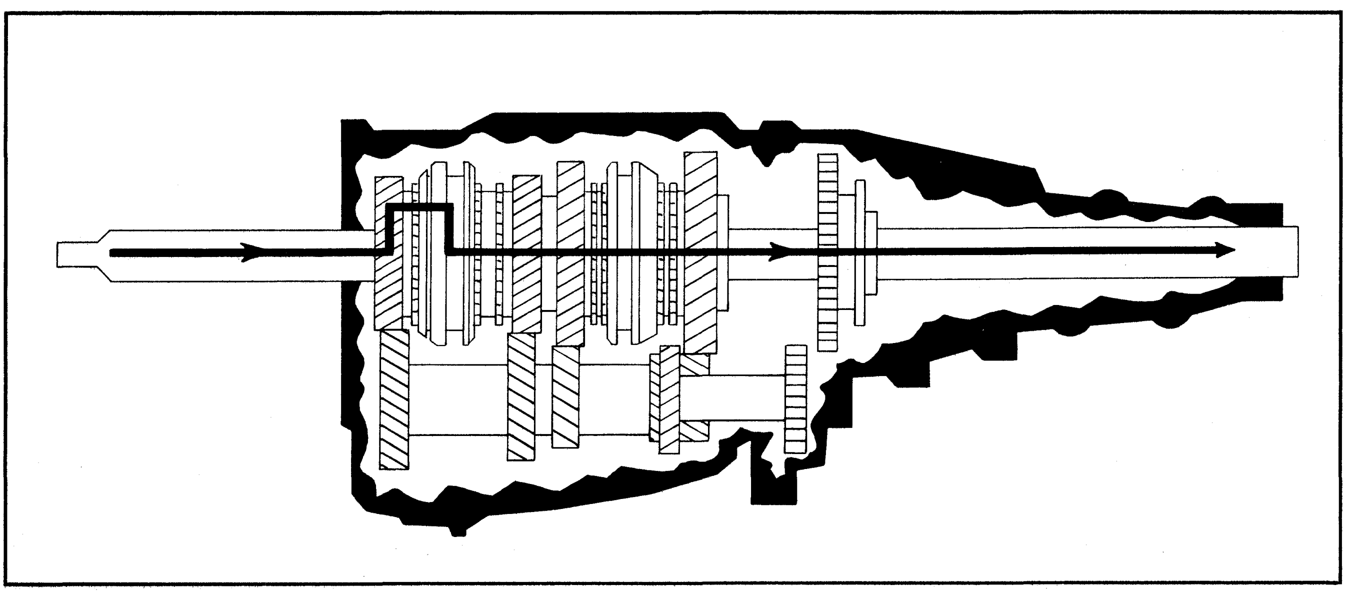


Fig. 7A-6 Four-Speed Synchromesh - Power Flow in Fourth Speed

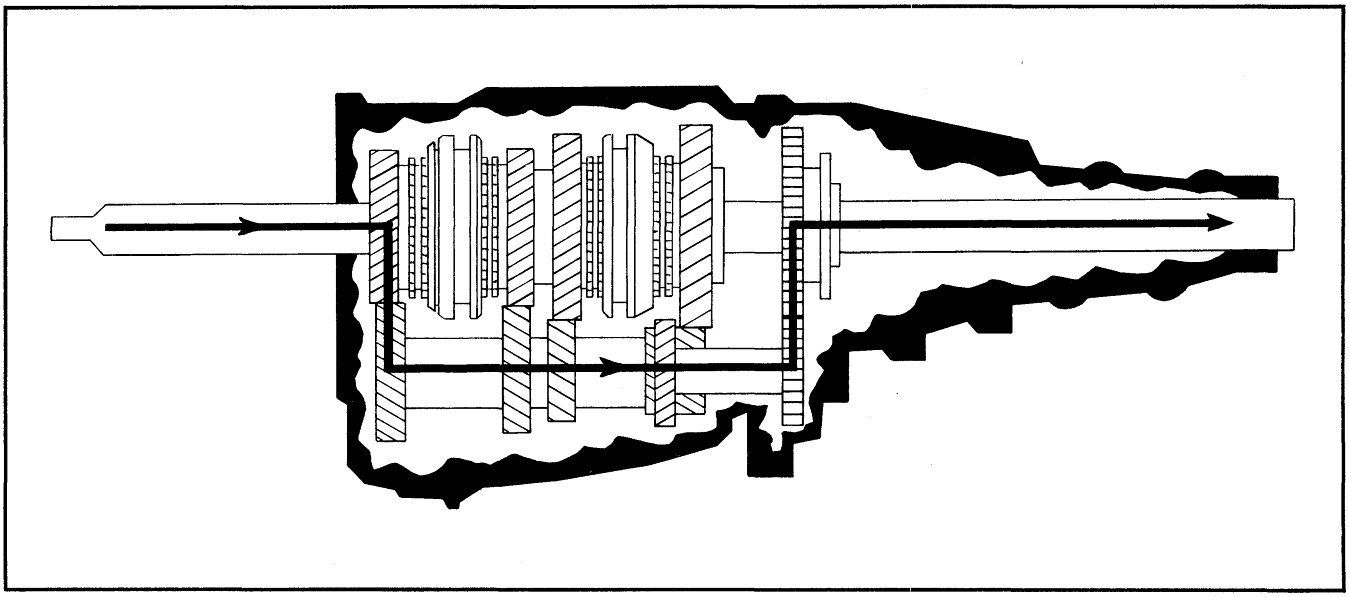


Fig. 7A-7 Four-Speed Synchromesh - Power Flow in Reverse

## ADJUSTMENTS ON CAR

### SHIFT LINKAGE ADJUSTMENTS (Fig. 7A-8)

*NOTE: In cases where the linkage has been disconnected, lubricate linkage joints with chassis grease and assemble shift rods to transmission levers and bracket assembly control levers. Tighten swivel nuts finger tight.*

1. Position selector lever in neutral position.

2. Loosen 3 swival nut assemblies.

3. Insert 1/4 diameter gauge pin into bracket and lever assembly control levers and align them in neutral position.

4. Position levers on transmission in neutral position.

5. Tighten swival nut assemblies to 8-12 lb. ft. torque.

6. Remove gauge pin.

7. Check complete shift pattern with engine off. Start engine and repeat complete shift pattern.

*NOTE: If shift rod adjustments are made as outlined above and clutch lash is correct (see Section 6D) shifting should be smooth in and out of any gear, with proper movement of selector lever by operator.*

## MINOR REPAIRS

### SPEEDOMETER DRIVEN GEAR—REMOVE

1. Disconnect speedometer cable.

2. Remove retainer to housing bolt and lockwasher and remove retainer.

3. Insert screwdriver in slot in fitting and pry fitting gear and shaft from housing.

4. Pry "O" ring from groove in fitting.

5. Check gear, shaft and fitting for wear and replace, if necessary.

*NOTE: Check for correct usage by referring to speedometer drive and driven gear usage chart in Section 1.*

### SPEEDOMETER DRIVEN GEAR—REPLACE

1. Install new "O" ring in groove of speedometer gear and sleeve assembly.

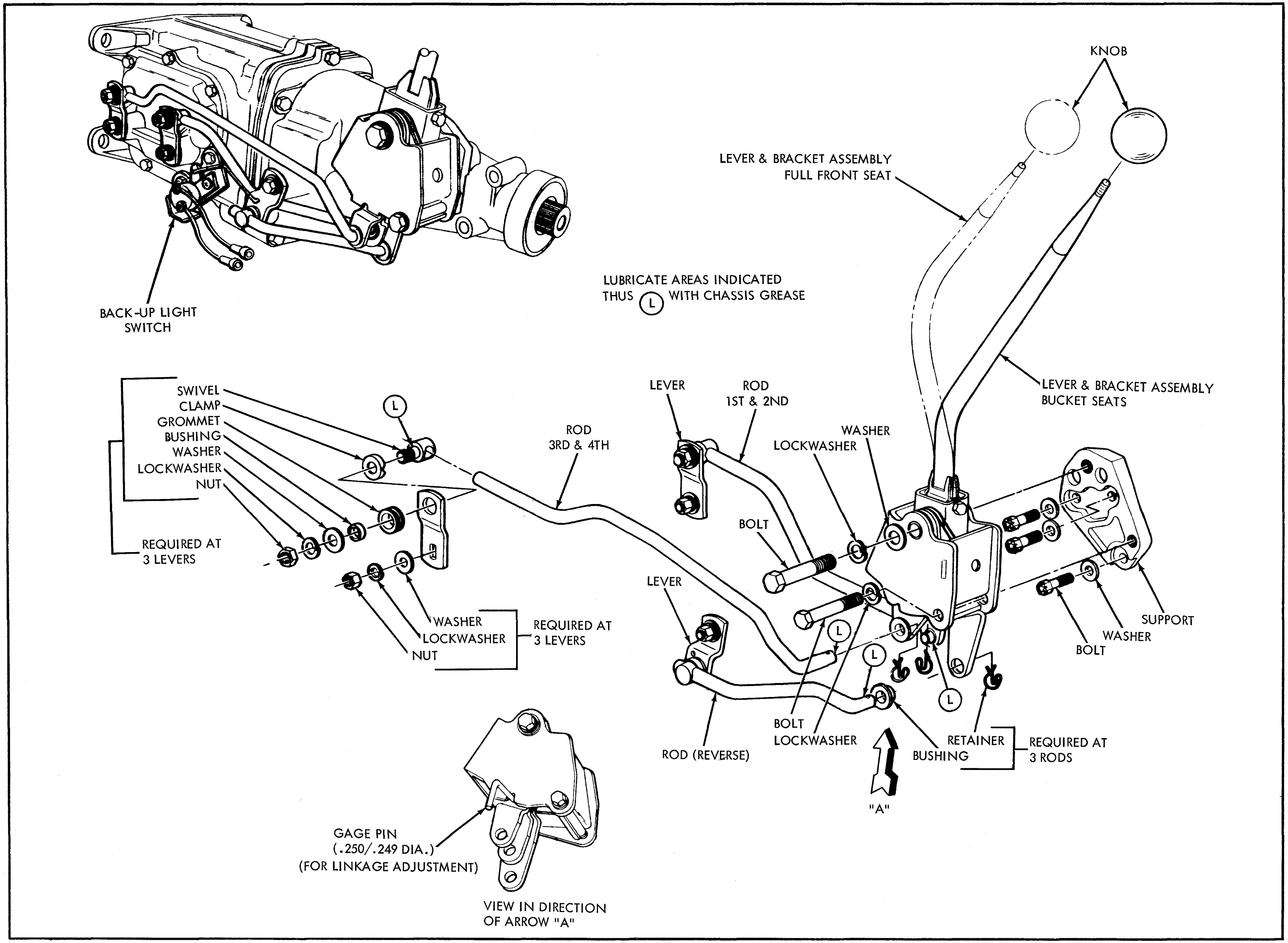



Fig. 7A-8 Gearshift Controls

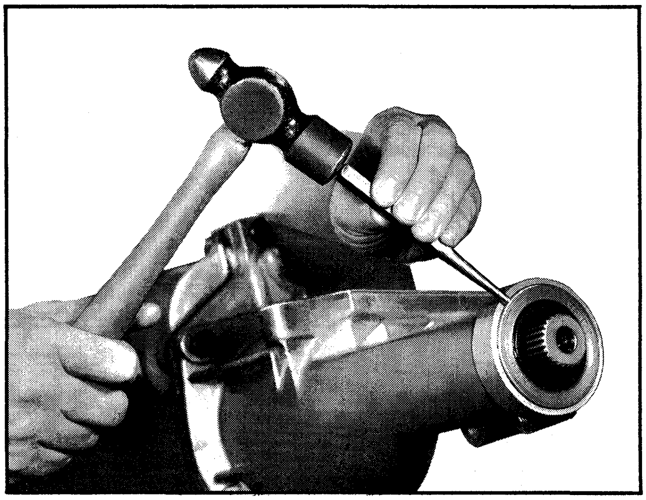


Fig. 7A-9 Removing Extension Oil Seal

2. Hold the assembly so slot is toward boss on housing and install in housing.

3. Push assembly into housing until retainer can be inserted into slot.

4. Install retainer bolt and lockwasher and tighten 35-60 lb. in. torque.

5. Connect speedometer cable to speedometer driven gear and sleeve assembly.

### TRANSMISSION EXTENSION OIL SEAL—REMOVE AND REPLACE

To inspect or replace the rear extension oil seal, it is necessary to remove the propeller shaft drive line assembly from the vehicle.

1. Remove U-bolt nuts, lock plates and U-bolts from rear axle drive pinion flange.

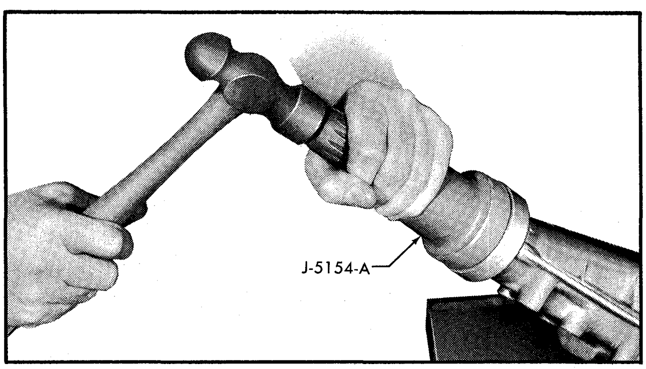



Fig. 7A-10 Installing Extension Oil Seal

2. Use suitable rubber band to hold bearings onto journals, if tie wire has been removed, to prevent loss of needle bearings when rear joint is disconnected.

3. Slide propeller shaft assembly rearward to disengage yoke from splines on transmission mainshaft.

4. Use punch or other suitable tool and loosen seal from extension and remove (Fig. 7A-9).

5. Wash counterbore with cleaning solvent and inspect for damage.

6. Inspect propeller shaft yoke for nicks, burrs or scratches which would cut new seal or cause seal to leak or damage bushing.

7. Coat new seal with sealing compound and press straight in bore of case extension with J-5154-A (Fig. 7A-10).

*CAUTION: Do not excessively force the seal against the seat in the extension.*

8. Install propeller shaft assembly by reversing steps 1 through 3 above. Coat outside diameter of yoke with gear lubricant before assembly.

### TRANSMISSION SIDE COVER—REMOVE AND DISASSEMBLE

It is not necessary to remove transmission from vehicle for inspection or replacement of parts in transmission side cover assembly, but the side cover assembly itself must be removed from transmission case (Fig. 7A-11).

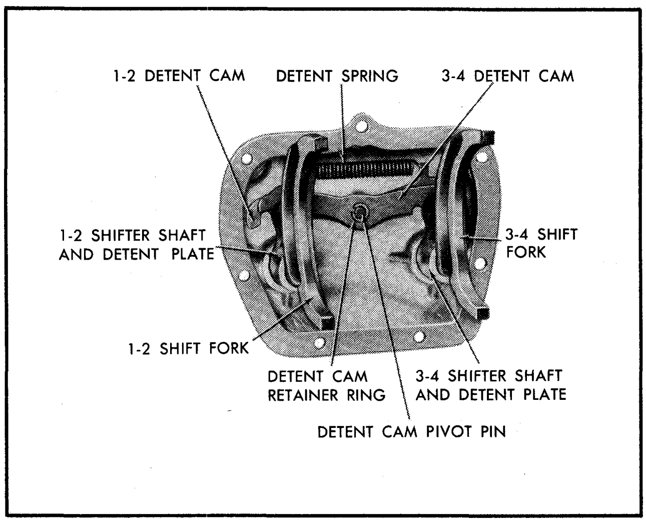



Fig. 7A-11 Transmission Side Cover Assy.

1. Remove drain plug at bottom of transmission and drain lubricant.

2. Disconnect control rods from levers (Fig. 7A-8).

3. Remove transmission side cover assembly from transmission case.

4. Remove the outer shift lever nuts and lockwashers and pull levers from shafts.

5. Carefully push the shift shafts into cover, allowing the detent balls to fall free, then remove both shifter shafts.

6. Remove interlock sleeve, interlock pin and poppet spring.

7. Inspect and replace necessary parts.

### *TRANSMISSION SIDE COVER—ASSEMBLE AND REPLACE*

1. Install interlock sleeve and one shifter shaft, positioning shift fork retaining hole toward flat, or top side, of cover.

2. Line up center, or neutral, groove of shifter shaft with interlock sleeve.

3. Place steel detent ball into sleeve followed by poppet spring and interlock pin.

4. Start second shifter shaft into position and place second detent ball on poppet spring. Compress ball and spring with screwdriver and, with center groove lined up with detent ball, push the shifter shaft fully in.

5. Install shifter levers on outer ends of shifter shafts.

6. With transmission in neutral and shifter forks and levers in place, lower side cover into place (Fig. 7A-12). Install attaching bolts and tighten evenly to 10-20 lb. ft. torque.

7. Remove filler plug at side of transmission and add 2.5 pints of SAE 90 "Multi-Purpose Gear Lubricant". Lubricant level should be approximately level with bottom of filler plug hole. Install plug.

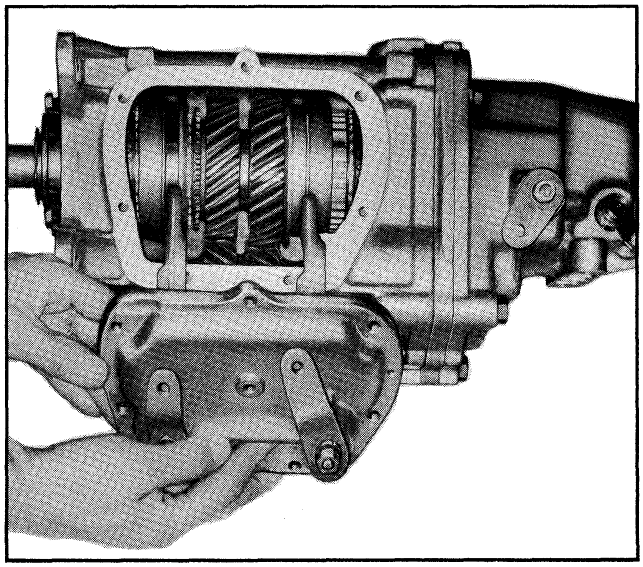


Fig. 7A-12 Installing Side Cover Assembly

## MAJOR REPAIRS

### *TRANSMISSION—REMOVE AND OVERHAUL*

1. Remove drain plug at bottom of transmission and drain lubricant.

2. Disconnect the speedometer cable from speedometer driven gear fitting and disconnect back-up light leads from back-up light switch (Fig. 7A-8).

3. Disconnect shift control rods from shifter levers. Remove two lever and bracket to extension support screws and remove manual shift lever and bracket.

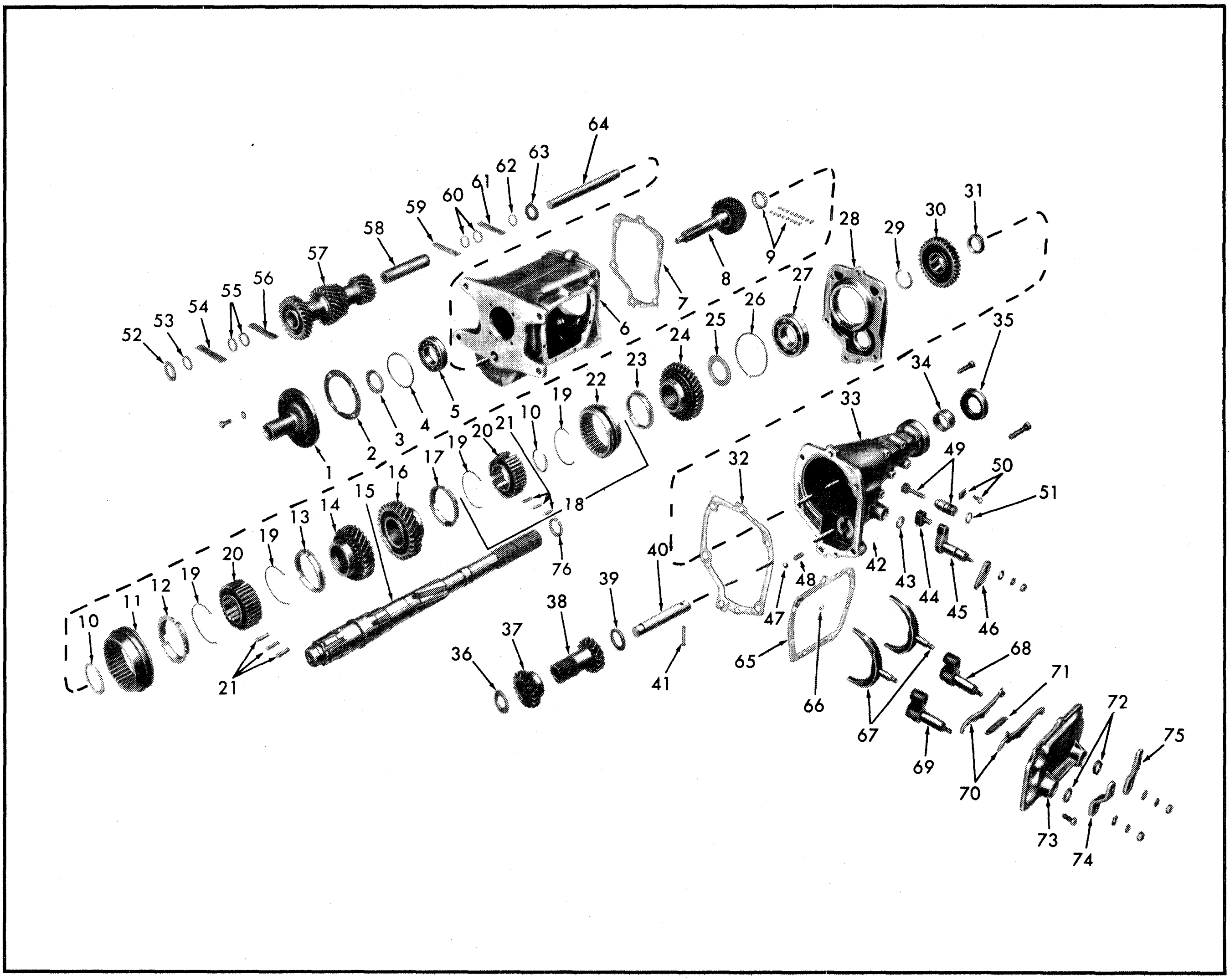
4. Remove propeller shaft drive line assembly.

   a. Remove U-bolt nuts, lock plates and U-bolts from rear axle drive pinion flange.

   b. Use a suitable rubber band to hold bearing onto journals, if the wire has been removed, to prevent loss of needle bearings when rear joint is disconnected.

   c. Remove complete drive line assembly by sliding rearward to disengage yoke from splines on transmission mainshaft.

5. Support rear of engine and remove two transmission extension insulator to cross member support retaining bolts. (See Fig. 6-14, 6 cyl., Fig. 6-94, 8 cyl.)



1. Bearing Retainer
2. Gasket
3. Bearing Retaining Nut
4. Bearing Snap Ring
5. Main Drive Gear Bearing
6. Transmission Case
7. Rear Bearing Retainer Gasket
8. Main Drive Gear
9. Bearing Roller (17) & Cage
10. Snap Ring
11. Third and Fourth Speed Clutch Sliding Sleeve
12. Fourth Speed Gear Synchronizing Ring
13. Third Speed Synchronizing Ring
14. Third Speed Gear
15. Mainshaft
16. Second Speed Gear
17. Second Speed Gear Synchronizing Ring
18. First and Second Speed Clutch Assembly
19. Clutch Key Spring
20. Clutch Hub
21. Clutch Keys
22. First and Second Speed Clutch Sliding Sleeve
23. First Speed Gear Synchronizing Ring
24. First Speed Gear
25. First Speed Gear Thrust Washer
26. Rear Bearing Snap Ring
27. Rear Bearing
28. Rear Bearing Retainer
29. Selective Fit Snap Ring
30. Reverse Gear
31. Speedometer Drive Gear
32. Rear Bearing Retainer to Case Extension Gasket
33. Case Extension
34. Extension Bushing
35. Rear Oil Seal
36. Reverse Idler Front Thrust Washer (Tanged)
37. Reverse Idler Gear (Front)
38. Reverse Idler Gear (Rear)
39. Flat Thrust Washer
40. Reverse Idler Shaft
41. Reverse Idler Shaft Roll Pin
42. Reverse Shifter Shaft Lock Pin
43. Reverse Shifter Shaft Lip Seal
44. Reverse Shift Fork
45. Reverse Shifter Shaft and Detent Plate
46. Reverse Shifter Lever
47. Reverse Shifter Shaft Detent Ball
48. Reverse Shifter Shaft Ball Detent Spring
49. Speedometer Driven Gear and Fitting
50. Retainer and Bolt
51. "O" Ring Seal
52. Tanged Wahser
53. Spacer (.050")
54. Bearing Rollers (20)
55. Spacers (2-.050")
56. Bearing Rollers (20)
57. Countergear
58. Countergear Roller Spacer
59. Bearing Rollers (20)
60. Spacers (2-.050")
61. Bearing Rollers (20)
62. Spacer (.050")
63. Tanged Washer
64. Countershaft
65. Gasket
66. Detent Cams Retainer Ring
67. Forward Speed Shift Forks
68. First and Second Speed Gear Shifter Shaft and Detent Plate
69. Third and Fourth Speed Gear Shifter Shaft and Detent Plate
70. Detent Cams
71. Detent Cam Spring
72. Lip Seals
73. Transmission Side Cover
74. Third and Fourth Speed Shifter Lever
75. First and Second Speed Shifter Lever
76. Special Snap Ring

Fig. 7A-13 Four-Speed Synchromesh Transmission - Exploded View

6. Remove the two top transmission to clutch housing bolts and insert two transmission aligning studs in these holes, J-1126.

*NOTE: The use of two aligning studs during this operation will support the transmission and prevent damage to the clutch disc through springing.*

7. Remove the two lower transmission to clutch housing bolts.

8. Tilt rear of extension upward to disengage bracket studs from cross member support and withdraw transmission from clutch housing.

9. Remove the transmission.

### TRANSMISSION—DISASSEMBLE

1. Remove transmission side cover assembly from transmission case.

*NOTE: If cover assembly is to be disassembled for inspection or replacement of worn parts, follow procedures 3 through 6 under TRANSMISSION SIDE COVER - REMOVE AND DISASSEMBLE.*

2. Remove insulator assembly from transmission rear extension.

3. Remove four bolts from front bearing retainer and remove retainer and gasket.

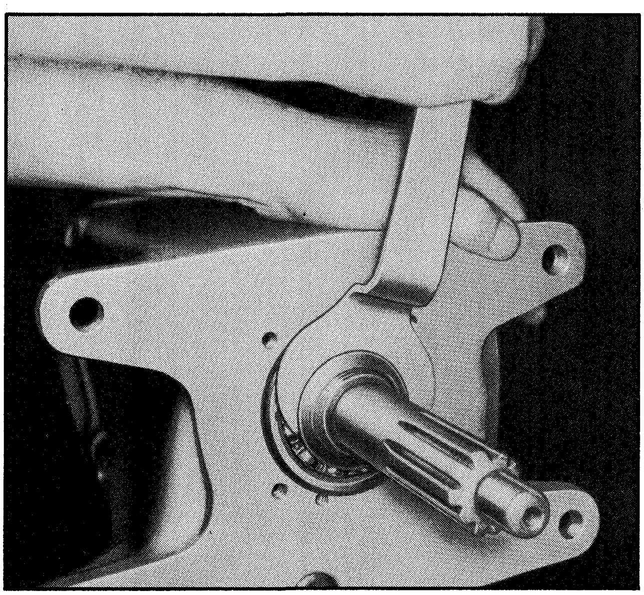


Fig. 7A-14 Removing or Replacing Main Drive Gear Retaining Nut

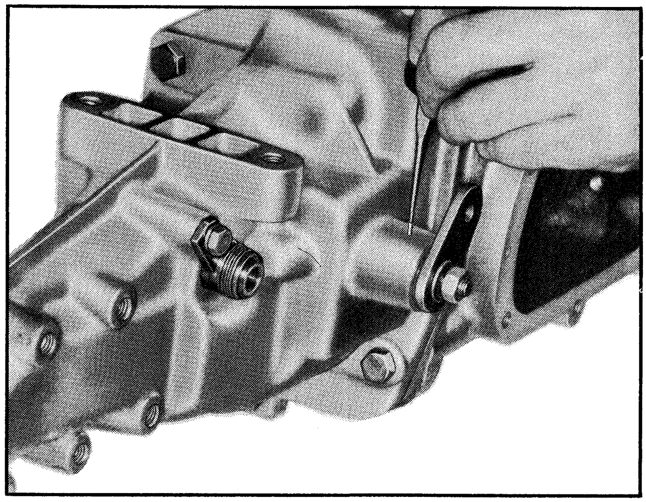


Fig. 7A-15 Removing Shifter Shaft Lock Pin

4. Remove the main drive gear retaining nut (Fig. 7A-14) using tool J-0933 after locking up transmission by shifting into two gears.

*NOTE: Nut has left hand threads.*

5. With transmission gears in neutral, drive lock pin from bottom side of reverse shift lever boss and pull shaft out about 1/8". This disengages the reverse shift fork from reverse gear (Fig. 7A-15).

6. Remove six bolts attaching the case extension to the rear bearing retainer. Tap extension with soft hammer in a rearward direction to start. When the reverse idler shaft is out as far as it will go, move extension to left so reverse fork clears reverse gear and remove extension and gasket.

7. The rear section of the reverse idler gear, shaft and tanged thrust washer may now be removed.

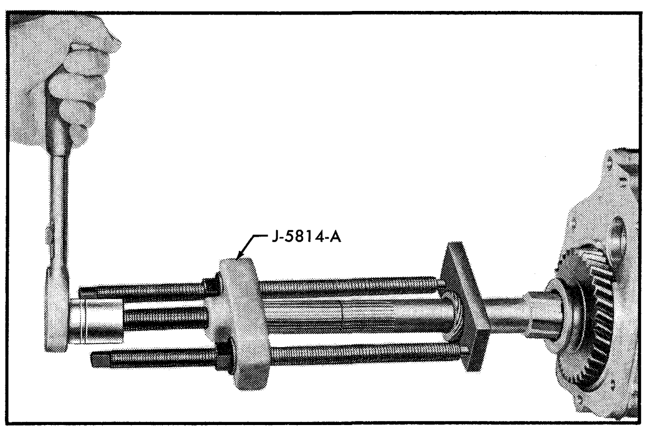



Fig. 7A-16 Removal of Speedometer Drive Gear

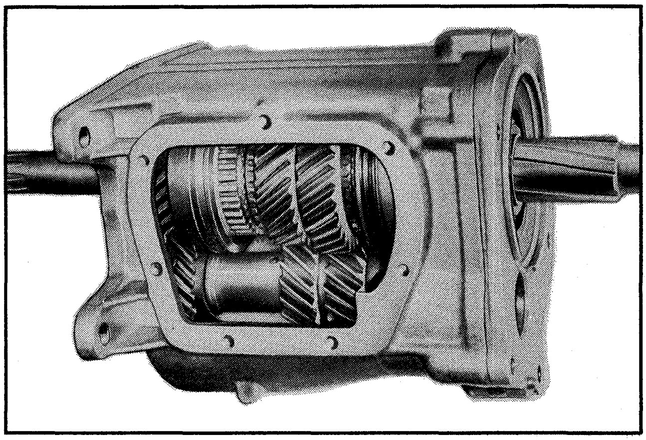


Fig. 7A-17 3-4 Speed Synchronizer Clutch Sleeve in 4th Gear

8. Remove special snap ring from rear spline of mainshaft.

9. Remove speedometer drive gear with J-5814-A as shown in Fig. 7A-16.

10. Slide 3-4 synchronizer clutch sleeve to 4th speed position (forward) (Fig. 7A-17).

11. Carefully remove the rear bearing retainer and entire mainshaft assembly from the case by tapping bearing retainer with a soft hammer.

12. Unload 17 bearing rollers and cage from main drive gear and remove fourth speed synchronizing ring.

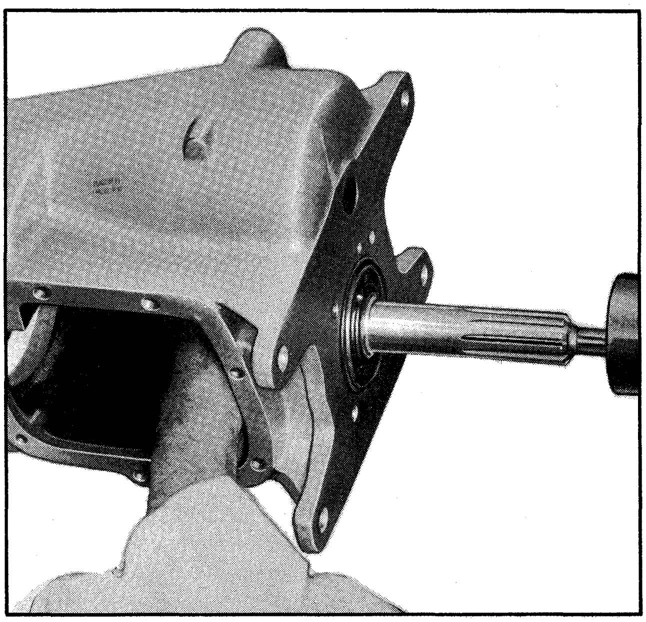


Fig. 7A-18 Removing Main Drive Gear from Front Bearing

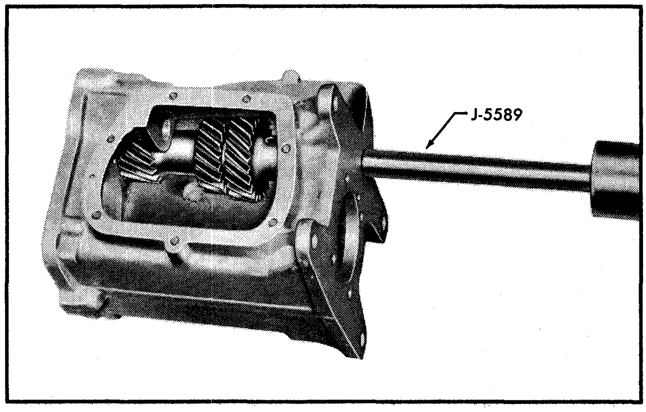



Fig. 7A-19 Removal of Countershaft

13. Lift the front reverse idler gear and thrust washer from case.

14. With soft hammer, tap main drive gear down from front bearing as shown in Fig. 7A-18.

15. From inside case, tap out front bearing and snap ring.

16. From the front of the case, tap out the countershaft, using loader J-5589, as shown in Fig. 7A-19. Remove the countergear and both tanged washers. Remove loader J-5589 from countergear.

17. Remove the 80 rollers, six .050" spacers and roller spacer from countergear (Fig. 7A-13).

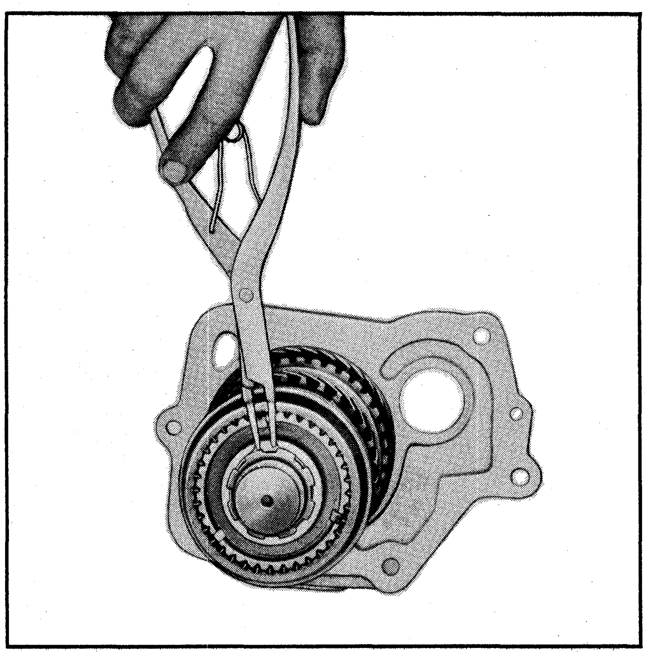


Fig. 7A-20 Removing or Replacing Mainshaft Front Snap Ring

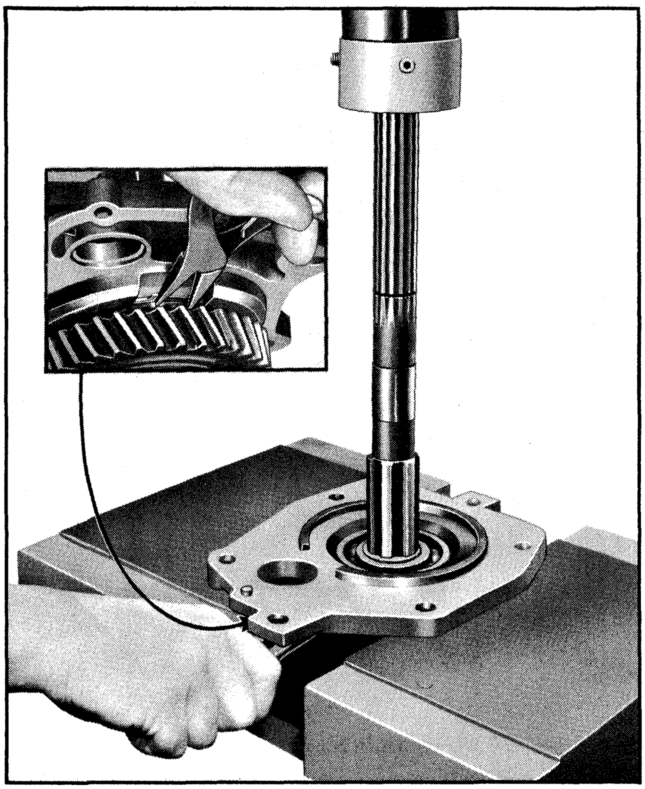


Fig. 7A-21 Removal of Mainshaft from Rear Bearing Retainer

18. Remove mainshaft front snap ring, as shown in Fig. 7A-20, and slide third and fourth speed clutch assembly, third speed gear and synchronizing ring, from front of mainshaft.

19. Spread rear bearing retainer snap ring and press mainshaft out of the retainer (Fig. 7A-21).

20. Remove the mainshaft rear snap ring. Support first and second speed clutch assembly, as shown in Fig. 7A-22, and press on rear of mainshaft to remove shaft from rear bearing, first speed gear thrust washer, first speed gear and synchronizing ring.

21. Remove 1-2 speed synchronizer clutch assembly retaining snap ring, Fig. 7A-23, and remove 1-2 synchronizer assembly, second speed synchronizer ring and second speed gear from mainshaft.

### *REVERSE SHIFTER SHAFT AND SEAL— REMOVE AND REPLACE*

1. With case extension removed from transmission the reverse shift shaft lock pin will already be removed. (See Step 5 under Disassembly).

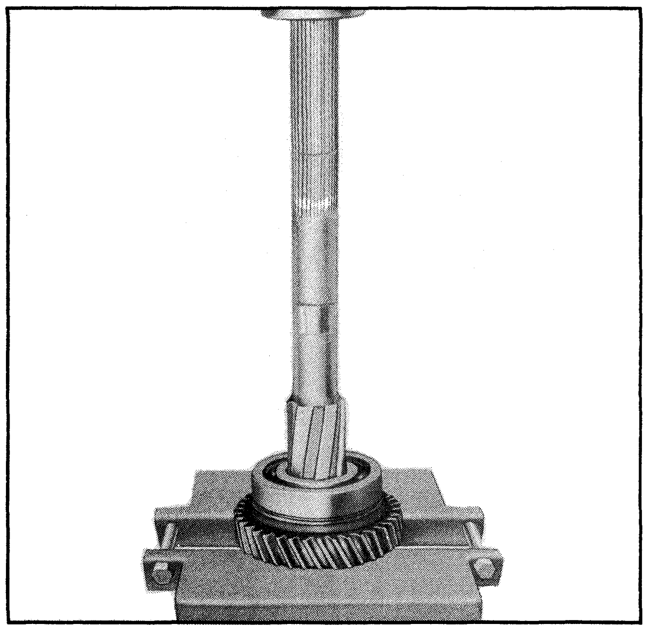


Fig. 7A-22 Removing Mainshaft From Rear Bearing and First Speed Gear

2. Remove shift fork.

3. Carefully drive shift shaft into case extension allowing ball detent to drop into case. Remove shaft and ball detent spring.

4. Place ball detent spring into detent spring hole and from inside of extension, install shifter shaft

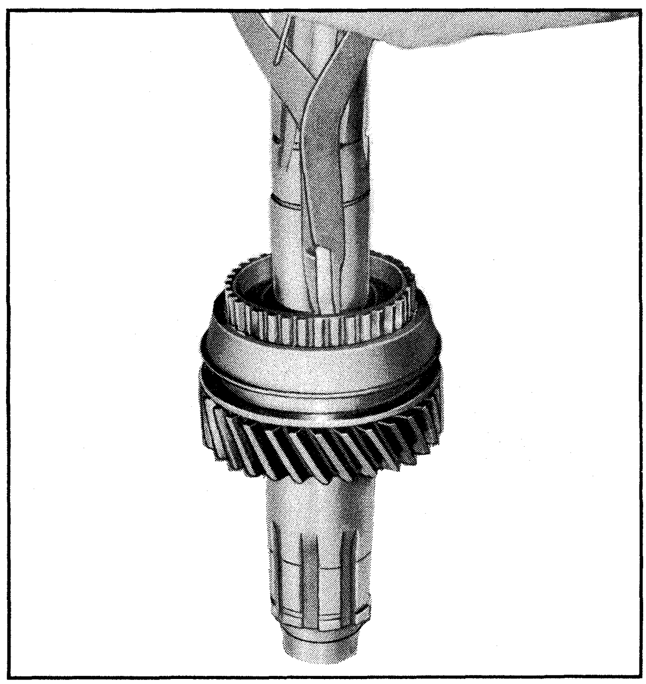


Fig. 7A-23 Removing 1-2 Speed Synchronizer Clutch Assy. Retainer Snap Ring

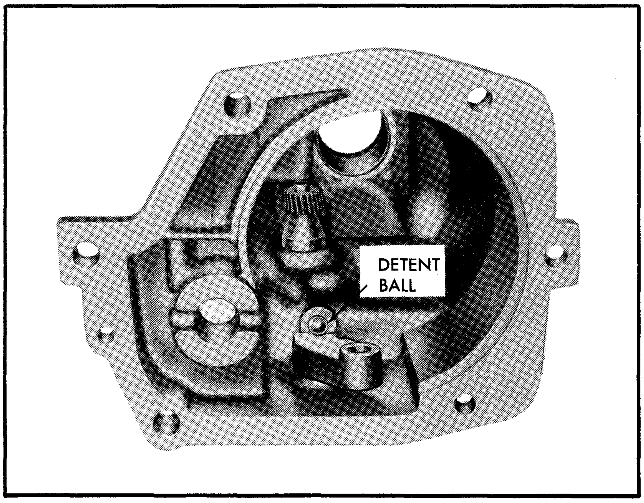



Fig. 7A-24 Installing Reverse Shifter Shaft

fully into its opening until the detent plate is butted against inside of extension housing.

5. Place detent ball on spring and, holding ball down with a suitable tool, push the shift shaft into place and turn until the ball drops into place in detent on the shaft detent plate (Fig. 7A-24).

6. Install shift fork.

*NOTE: Do not drive the shift shaft lock pin into place until the extension has been installed on the transmission case.*

### TRANSMISSION EXTENSION CASE BUSHING AND OIL SEAL—REMOVE & REPLACE

1. Remove oil seal with punch or other suitable tool (Fig. 7A-9).

2. Using tool J-6399, drive bushing forward into case extension (Fig. 7A-25).

3. Drive new bushing in from rear of case extension with same tool (J-6399), until end of bushing is slightly below counterbore for oil seal.

4. Coat I.D. of bushing with transmission oil, and new seal with sealing compound and start straight in bore of case extension. Using installer J-5154-A tap seal into extension case (Fig. 7A-10).

*CAUTION: Do not excessively force the seal against the seat in the extension.*

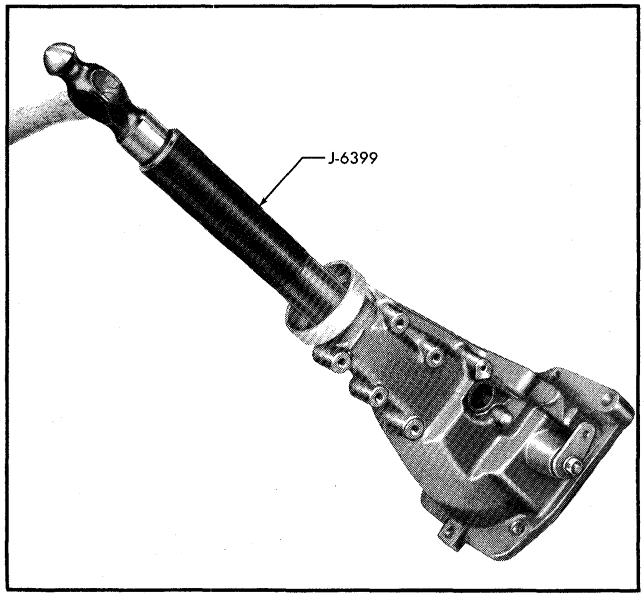



Fig. 7A-25 Removing or Installing Extension Case Bushing

### CLUTCH KEYS AND SPRING—REMOVE AND REPLACE

*NOTE: The clutch hubs and sliding sleeves are a selected assembly and should be kept together as originally assembled, but the three keys and two springs may be replaced if worn or broken.*

1. Push the hub from the sliding sleeve. The keys will fall free and the springs may be easily removed.

2. Place the two springs in position (one on each side of the hub), so a tanged end of each spring falls into the same keyway in the hub. Place the keys in position and, holding them in place, slide the hub into the sleeve.

## CLEANING AND INSPECTION

### TRANSMISSION CASE

Wash the transmission case inside and out with a cleaning solvent and inspect for cracks. Inspect the front face which fits against clutch housing for burrs and if any are present, dress them off with a fine cut mill file.

### FRONT AND REAR BEARINGS

1. Wash the front and rear bearing thoroughly in a cleaning solvent.

2. Blow out bearings with compressed air.

*CAUTION: Do not allow the bearings to spin, turn them slowly by hand. Spinning bearings will damage the race and balls.*

3. Make sure the bearings are clean, then lubricate them with light engine oil and check them for roughness. Roughness may be determined by slowly turning the outer race by hand.

### BEARING ROLLERS AND SPACERS

All main drive gear and countergear bearing rollers should be inspected closely and replaced if they show wear. Inspect countershaft at the same time and replace if necessary. Replace all worn spacers.

### GEARS AND BUSHING

Inspect all gears and first speed gear bushing and, if necessary, replace all that are worn or damaged.

### REVERSE IDLER

1. The bushings used in the idler gear are pressed into the gear then peened into holes in the bores, and are bored in place. This insures the positive alignment of the bushings and their shafts, as well as proper meshing of the gears. Because of the high degree of accuracy to which these parts are machined, the bushings are not serviced separately.

2. Check bushings for excessive wear by using a narrow feeler gauge between the shaft and the bushing or use a micrometer. The proper clearance is from .003" to .005".

## TRANSMISSION—ASSEMBLE

### Mainshaft Assembly

1. From the rear of the mainshaft, assemble the second speed gear (with hub of gear toward rear of shaft).

2. Install 1-2 Synchronizer clutch assembly to mainshaft (sliding clutch sleeve taper toward the rear, hub to the front); together with a synchronizing ring on either side so their keyways line up with the clutch keys (Fig. 7A-26). Install smaller of two synchronizer retaining snap rings to mainshaft with ends of snap ring behind spline teeth.

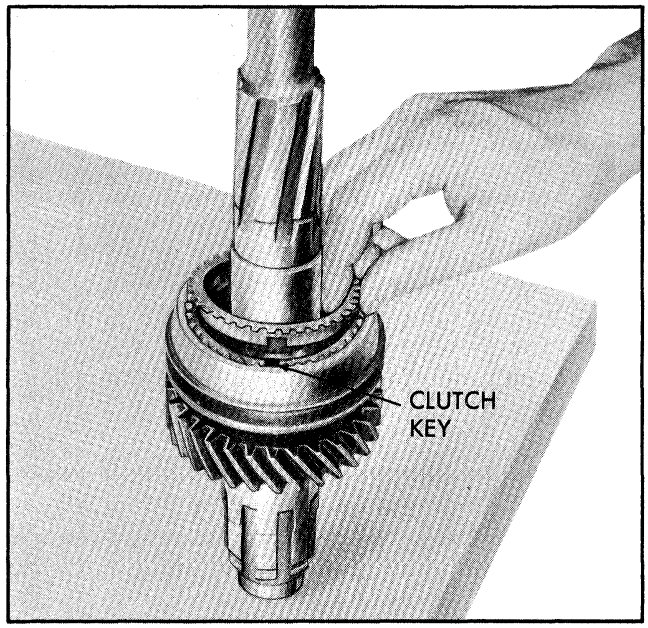



Fig. 7A-26 Installing Synchronizer Ring

3. Install the first speed gear (with hub toward front) and first speed gear thrust washer.

4. Using 1-5/8" I.D. pipe cut to a suitable length, press on the rear bearing with the snap ring groove toward the front of the transmission (Fig. 7A-27).

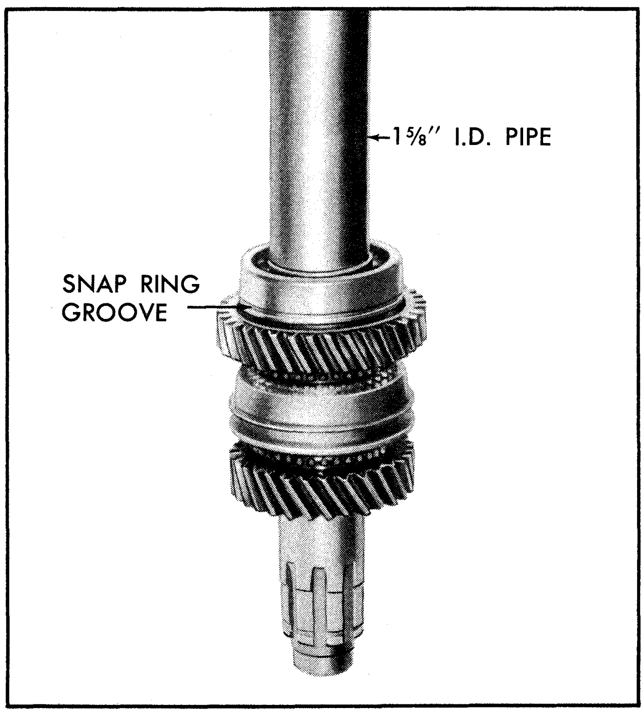



Fig. 7A-27 Installing Rear Bearing

5. Choose the correct selective fit snap ring (.084", .087", .090", .093", or .096") and install it in the groove in mainshaft behind the rear bearing. With proper ring, maximum distance between snap ring and rear face of bearing will be from zero to .005".

*NOTE: Always use new snap rings when reassembling transmission and do not expand the snap ring further than is necessary for assembly.*

6. Install the third speed gear (hub to front of transmission) and the third speed gear synchronizing ring (notches to front of transmission).

7. Install the third and fourth speed gear clutch assembly (hub and sliding sleeve) with both sleeve taper and hub toward the front, making sure the keys in the hub correspond to the notches in the third speed gear synchronizing ring.

8. Install snap ring in the groove in mainshaft in front of the third and fourth speed clutch assembly, with ends of snap ring seated behind spline teeth.

9. Install the rear bearing retainer (Fig. 7A-28). Spread the snap ring in the plate to allow the snap ring to drop around the rear bearing and press on the end of the mainshaft until the snap ring engages the groove in the rear bearing.

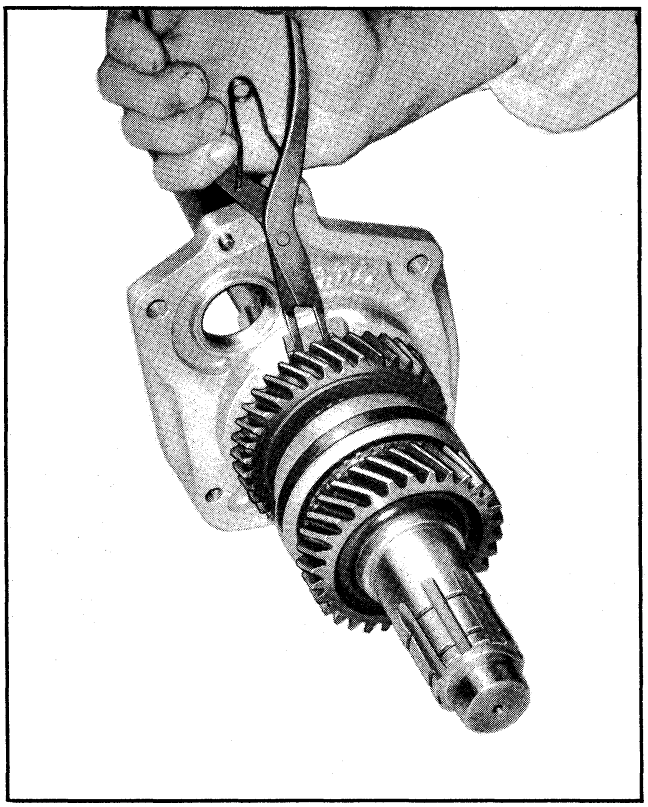


Fig. 7A-28 Installing Rear Bearing Retainer

10. Install the reverse gear (shift collar to rear).

11. Press speedometer drive gear onto the mainshaft using a suitable press plate. Position the speedometer gear to get a measurement of 4-5/16" from the forward side of the gear to the flat surface of the rear bearing retainer (Fig. 7A-29) or until centered on the mainshaft speedometer drive gear boss.

*CAUTION: Make certain correct speedometer drive gear is installed. Refer to Speedometer Gear Usage Chart in Section I.*

12. Install special snap ring in groove at rear spline of mainshaft (Fig. 7A-13).

#### Countergear Assembly

1. Install roller spacer in countergear.

2. Using heavy grease to retain the rollers, install 20 rollers in either end of the countergear, two .050" spacers, 20 more rollers, then one .050" spacer. Install in the other end of the countergear, 20 rollers, two .050" spacers, 20 more rollers, and another .050" spacer (Fig. 7A-30).

3. Insert tool J-5589 into countergear.

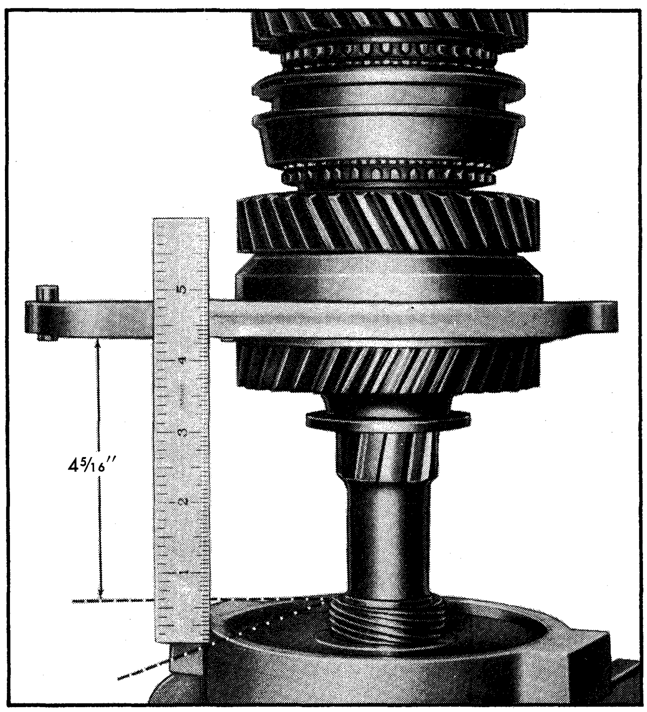



Fig. 7A-29 Installing Speedometer Drive Gear

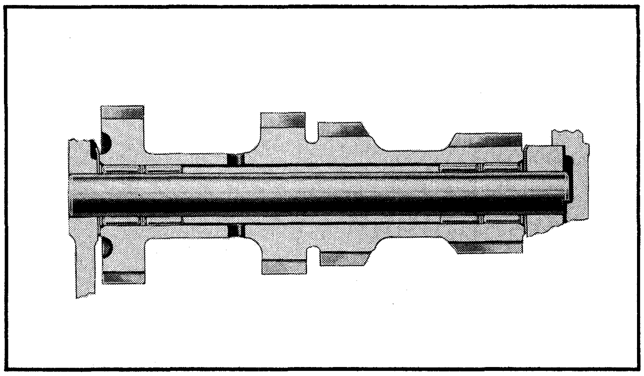


Fig. 7A-30 Cross-Section of Countergear Assembly

***Transmission Assembly***

1. Rest the transmission case on its side with the side cover opening toward the assembler. Put countergear tanged thrust washers in place, retaining them with heavy grease, making sure the tangs are resting in the notches of the case.

2. Set countergear in place in bottom of transmission case, making sure that tanged thrust washers are not knocked out of place.

3. Position the transmission case resting on its front face.

4. Lubricate and insert countershaft in rear of case. Turn countershaft so flat on end of shaft is horizontal and facing bottom of case.

*NOTE: The flat on shaft must be horizontal and toward the bottom to mate with rear bearing retainer when installed.*

5. Align countergear with shaft in rear and hole in front of case, and press countershaft into case (pushing assembly tool out front of case) until flat on shaft is flush with rear of case. Be sure thrust washers remain in place (Fig. 7A-31).

6. Attach a dial indicator as shown in Figure 7A-32 and check end play of the countergear. If end play is greater than .025" new thrust washers must be installed.

7. Install the seventeen roller bearings into main drive gear, using heavy grease to hold the bearings and cage in place.

8. Install main drive gear and pilot bearings through the side cover opening and into position in transmission front bore.

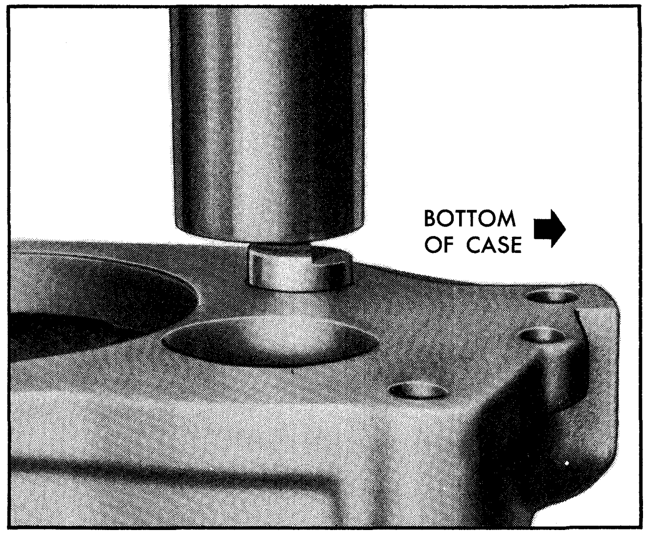



Fig. 7A-31 Installing Countershaft

9. Place gasket in position on front face of rear bearing retainer.

10. Install the fourth speed synchronizing ring on main drive gear with the notches toward the rear of the transmission.

11. Position the reverse idler gear thrust washer (tanged) on the machined face of the ear cast in the case for the reverse idler shaft and hold with heavy grease. Position the front reverse idler gear next to the thrust washer, with the hub facing toward rear of the case.

*CAUTION: Before attempting to install mainshaft assembly to case, slide the 3-4 synchronizing clutch sleeve forward into fourth speed detent position (Fig. 7A-17).*

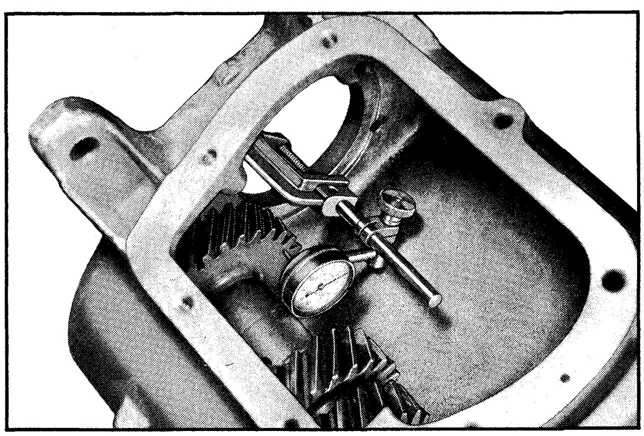


Fig. 7A-32 Checking Countergear End Play

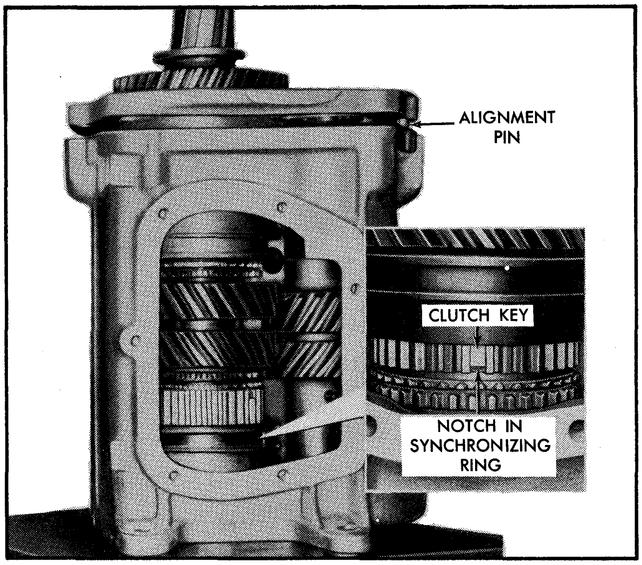



Fig. 7A-33 Installing Mainshaft Assembly

12. Lower the mainshaft assembly into the case making certain the notches on the fourth speed synchronizing ring correspond to the keys in the clutch assembly (Fig. 7A-33).

13. With the guide pin in rear bearing retainer aligned with hole in rear of case, tap rear bearing retainer into position with a soft hammer.

14. From the rear of the case, insert the rear reverse idler gear, engaging the splines with the portion of the front gear inside the case.

15. Using heavy grease, place gasket in position on rear face of rear bearing retainer.

16. Install the remaining flat thrust washer on reverse idler shaft. If new idler shaft is being used, drive out the roll pin and press it into new shaft.

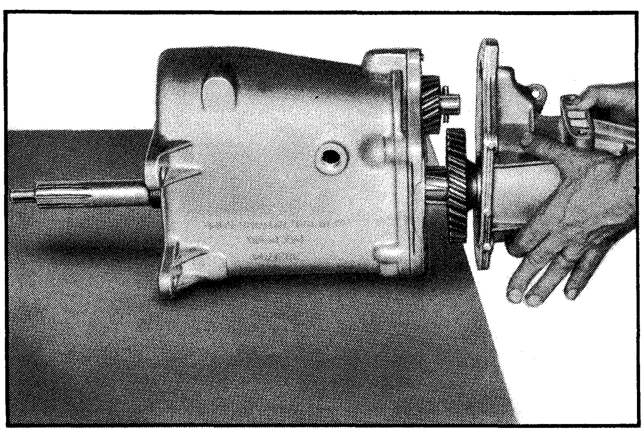


Fig. 7A-34 Installing Case Extension

17. Install reverse idler shaft, roll pin, and thrust washer into gears and front boss of case. Make sure to pickup front tanged thrust washer.

*NOTE: Roll pin should be in a vertical position.*

18. Position reverse gear at rear of spline, pull reverse shifter shaft to left side of extension and rotate shaft to bring reverse shift fork forward in extension (reverse detent position). Start the extension onto the transmission case (Fig. 7A-34), while slowly pushing in on the shifter shaft to engage the shift fork with the reverse gear shift collar. Then pilot the reverse idler shaft into the extension housing permitting the extension to slide onto the transmission case.

19. Install 6 extension and retainer-to-case attaching bolts. Torque upper 3 bolts to 15-25 ft. lbs.; lower 3 bolts to 25-35 ft. lbs.

20. Push or pull reverse shifter shaft to line up groove in the shaft with the holes in the boss and drive in the lock pin. Install shifter lever.

21. Press bearing onto main drive gear (snap ring groove to front) and into case until several main drive gear retaining nut threads are exposed.

22. Lock transmission up by shifting into two gears. Install main drive gear retaining nut on the gear shaft and draw it up tight using tool J-0933. Be sure bearing fully seats against shoulder on gear. Torque retaining nut to 40 ft. lbs. and lock in place by staking securely into main drive gear shaft hole with a center punch. Care must be used to avoid damaging the threads on the shaft.

23. Install the main drive gear bearing retainer, gasket and four attaching bolts using a suitable sealer on bolts. Torque to 14 to 22 ft. lbs.

24. Shift mainshaft 3-4 sliding clutch sleeve into neutral position and 1-2 sliding clutch sleeve into second gear (forward) detent position. Shift side cover 3-4 shifter lever into neutral detent and 1-2 shifter lever into second gear detent position.

25. Install side cover gasket and carefully position side cover into place. There is a dowel pin in the cover to assure proper alignment with the case. Install attaching bolts and tighten evenly to avoid side cover distortion. Torque to 14-22 ft. lbs.

26. Install insulator assembly on rear extension. Torque bolts to 25-35 lb. ft.

27. If lever and bracket support to extension was removed, reinstall tightening 3 bolts 20-35 lb. ft. torque.

## TRANSMISSION—INSTALL IN VEHICLE

1. Raise transmission until rear extension can be moved rearwards over center cross member support.

*NOTE: If it was necessary to remove cross member support before removing transmission, install support while transmission is held in a raised position.*

2. Move transmission forward until extension bracket studs engage holes in cross member support and main drive gear shaft enters clutch housing. Care should be taken to make certain clutch release bearing remains seated.

3. Install aligning stud J-1126 in lower right transmission to clutch housing bolt hole for alignment.

4. Install two upper transmission to clutch housing mounting bolts and washers and tighten securely to 45-60 lb. ft. torque. Remove aligning stud and install two lower mounting bolts and washers and tighten 45-60 lb. ft. torque.

5. Install rear extension to cross member support insulator and tighten bolts 25-35 lb. ft. torque.

6. Install propeller shaft drive line assembly by reversing steps a. through c. under TRANSMISSION --REMOVE FROM VEHICLE.

7. Install manual shift lever and secure shift bracket to transmission rear extension support with two bracket to extension bolts. Tighten upper bolt 40-55 lb. ft. torque. Tighten lower bolt 20-35 lb. ft. torque.

8. Connect shift rods to shift bracket at rear extension. See Gearshift Linkage Adjustment Page 7A-6.

9. Connect speedometer cable to speedometer driven gear and tighten securely.

10. Connect back-up light leads to back-up light switch leads, using female connectors.

11. If rubber boot or console was removed, slide rubber boot with metal boot retainer over shift stick and secure to floor plate with six metal screws. Install console. (See Fig. 7-11, Section 7 for exploded view of console.)

12. Remove filler plug at side of transmission and add 2.5 pints of SAE 90 "Multi-purpose Gear Lubricant". Lubricant level should be approximately level with bottom of filler plug hole. Install plug.

13. Check shift pattern and adjust as required.

## TROUBLE DIAGNOSIS AND TESTING

| TROUBLE | REMEDY |
|---|---|
| ***SLIPS OUT OF HIGH GEAR*** | |
| a. Transmission loose on clutch housing. | a. Tighten mounting bolts |
| b. Does not fully engage. | b. Adjust threaded clevis on each shift rod until proper adjustment is attained. |
| c. Damaged mainshaft pilot bearing. | c. Replace pilot bearing. |
| d. Main drive gear bearing retainer broken or loose. | d. Tighten or replace main drive gear bearing retainer. |
| e. Dirt between transmission case and clutch housing. | e. Clean mating surfaces. |
| f. Misalignment of transmission. | f. Shim between transmission case and clutch housing. |

| TROUBLE | REMEDY |
|---|---|
| ***SLIPS OUT OF REVERSE GEAR*** | |
| a. Reverse gear damaged from operating at part engagement. | a. Determine cause. For example: worn shift fork and control lever or rod interference. Replace worn or bent parts. |
| b. Improperly adjusted linkage. | b. Adjust linkage. |
| ***NOISY IN ALL GEARS*** | |
| a. Insufficient lubricant. | a. Fill to correct level. |
| b. Worn countergear bearings. | b. Replace countergear bearings and shaft. |
| c. Worn or damaged main drive gear and countergear. | c. Replace worn or damaged gears. |
| d. Damaged main drive gear or mainshaft ball bearings. | d. Replace damaged bearings or gear. |
| ***NOISY IN HIGH GEAR*** | |
| a. Damaged main drive gear bearing. | a. Replace damaged bearing. |
| b. Damaged mainshaft bearing. | b. Replace damaged bearing. |
| ***NOISY IN THIRD GEAR*** | |
| a. Damaged or worn third speed constant mesh gears. | a. Replace damaged gears. |
| b. Worn or damaged countergear rear bearings. | b. Replace countergear bearings and shaft. |
| ***NOISY IN SECOND GEAR*** | |
| a. Damaged or worn second speed constant mesh gears. | a. Replace damaged gears. |
| b. Worn or damaged countergear rear bearings. | b. Replace countergear bearings and shaft. |
| ***NOISY IN FIRST GEAR*** | |
| a. Damaged or worn first speed constant mesh gears. | a. Replace damaged gears. |
| b. Worn or damaged countergear rear bearings. | b. Replace countergear bearings and shaft. |

| TROUBLE | REMEDY |
|---|---|
| ***NOISY IN REVERSE ONLY*** | |
| a. Worn or damaged reverse idler gear. | a. Replace reverse idler gear assembly. |
| b. Worn reverse idler bushings. | b. Replace reverse idler gear assembly. |
| c. Damaged or worn reverse speed gear. | c. Replace reverse gear. |
| ***NOISY IN NEUTRAL WITH ENGINE RUNNING*** | |
| a. Damaged main drive bearing. | a. Replace damaged bearing. |
| ***NOISY IN ALL REDUCTION GEARS*** | |
| a. Insufficient lubricant. | a. Fill to correct level. |
| b. Worn or damaged main drive gear or countergear. | b. Replace faulty or damaged gears. |
| ***EXCESSIVE BACKLASH IN SECOND ONLY*** | |
| a. Second speed gear bearing thrust washer worn. | a. Replace bearing thrust washer. |
| b. Mainshaft rear bearing not properly installed in retainer. | b. Replace bearing, snap ring or retainer as necessary. |
| c. Worn countergear rear bearings. | c. Replace countergear bearings and shaft. |
| ***EXCESSIVE BACKLASH IN ALL REDUCTION GEARS*** | |
| a. Worn countergear bushings. | a. Replace countergear. |
| b. Excessive end play in countergear. | b. Replace countergear thrust washers. |
| ***LEAKS LUBRICANT*** | |
| a. Excessive amount of lubricant in transmission. | a. Drain to correct level. |
| b. Loose or broken main drive gear bearing retainer. | b. Tighten or replace retainer. |
| c. Main drive gear bearing retainer gasket damaged. | c. Replace gasket. |
| d. Cover loose or gasket damaged. | d. Tighten cover or replace gasket. |
| e. Operating shaft seal leaks. | e. Replace operating shaft seal. |
| f. Countershaft loose in case. | f. Replace case. |

## TRANSMISSION SPECIFICATIONS

The car serial number is located on top of the transmission at the rear bearing retainer.

The transmission face, clutch housing and block are accurately squared in production so that each unit may be interchanged as necessary. Special alignment of these assemblies is not necessary if they are installed properly.

| Shift Positions | Gear Ratios |
|---|---|
| First | 2.56 |
| Second | 1.91 |
| Third | 1.48 |
| Fourth | 1.00 |
| Reverse | 2.64 |
| Lubricant Capacity | 2.5 pints |

## TORQUE SPECIFICATIONS

| | Lb. Ft. |
|---|---|
| Main Drive (Clutch) Gear Retainer Bolts | 14-22 |
| Side Cover Bolts | 14-22 |
| Extension to Case Bolts (3 Upper) | 15-24 |
| Extension to Case Bolts (3 Lower) | 25-35 |
| Shift Lever to Shifter Shaft Nuts | 14-22 |
| Transmission Filler Plug | 25-35 |
| Lever and Bracket Support to Extension Bolts | 20-35 |
| Lever and Bracket Assembly to Support Bolt (Upper) | 40-55 |
| Lever and Bracket Assembly to Support Bolt (Lower) | 20-35 |
| Rear Extension to Cross Member Support Insulator Bolts | 25-35 |
| Transmission to Clutch Housing Bolts | 45-60 |
| Transmission Control Rod to Transmission Lever Nuts | 8-12 |

| | Lb. In. |
|---|---|
| Speedometer Driven Gear Retainer to Transmission Screw | 35-60 |
| Speedometer Cable to Driven Gear Nut | 40-50 |

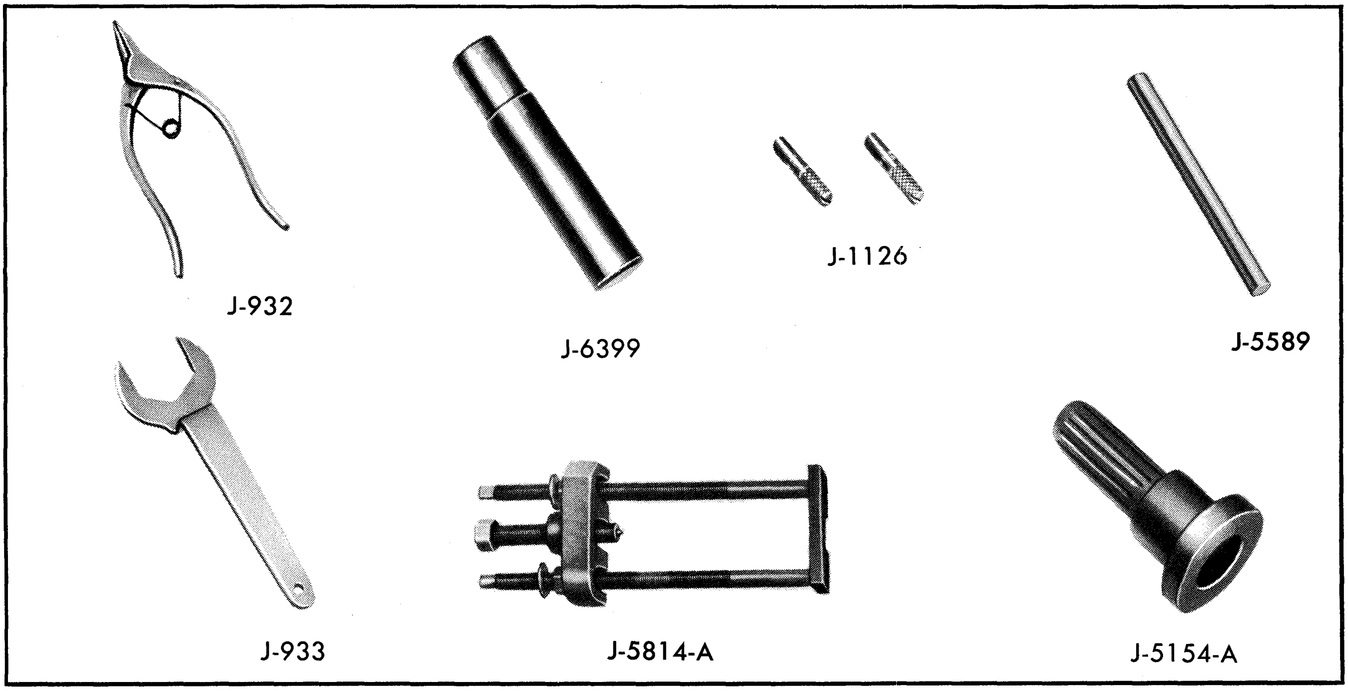



Fig. 7A-35 Four-Speed Transmission Special Tools

## SPECIAL TOOLS

| | |
|---|---|
| J-932 | Snap Ring Pliers |
| J-933 | Clutch Gear Retainer Nut Wrench |
| J-1126 | Aligning Studs |
| J-5154-A | Transmission Extension Oil Seal Installer |
| J-5589 | Countershaft Bearing Loader |
| J-6399 | Rear Bearing Extension Bushing—Remove and Replace |
| J-5814-A | Speedometer Drive Gear Remover |

# AUTOMATIC TRANSMISSION

## CONTENTS OF THIS SECTION



## GENERAL DESCRIPTION

The Pontiac Tempest automatic transmission (Fig. 7B-1) is a combination torque converter, two-speed planetary geared transmission. Torque multiplication is obtained hydraulically through the converter, and mechanically through a compound planetary gear set. The gear set, in combination with the torque converter, provides a high starting ratio for acceleration from a stop, up steep grades, etc. The torque converter provides torque multiplication for performance and smooth operation. The converter functions as a fluid coupling at normal road load conditions and at higher speeds. The L-6 transmission is air-cooled and the V-8 transmission is water-cooled. Description of the transmission is divided into eight basic sections: (1) Torque Converter, (2) Oil Pump, (3) Planetary Gear Set and Controls, (4) Forward Clutch, (5) Low Band, (6) Reverse Clutch, (7) Governor, (8) Valve Body.

### *TRANSMISSION IDENTIFICATION*

The transmission name plate is located on the right side of the transmission (Fig. 7B-2). The transmission model number and the assembly date code appear on the name plate. Model numbers are as follows:

20 - L-6 air-cooled

30 - V-8 water-cooled

The first two digits of the assembly date code denote the model year and the digits following the dash represent the production build day.

It is very important that any communication concerning this transmission contain the model number and date code and that all transmission parts returned to Pontiac Motor Division be tagged with this information .

### *TORQUE CONVERTER OPERATION*

The torque converter is a device that multiplies engine torque. The converter assembly has three members: a driving member called the converter pump, a driven member called the turbine, and a stator located between the pump and turbine. The three components are immersed in oil. The converter pump is mechanically connected to the engine. When the engine is running, oil within the converter cavity is maintained under pressure by the oil pump. Oil is then picked up at the inner section of the converter pump and directed to its outer edges where it is thrown against the curved blades in the turbine. This causes the turbine to rotate, driving the input shaft. As the oil leaves the turbine blades it is traveling in a direction relatively opposite to the pump rotation. The blades of the stator (curved in the opposite direction to those in the turbine) change the direction of oil flow so that the oil strikes the back side of the converter pump blades

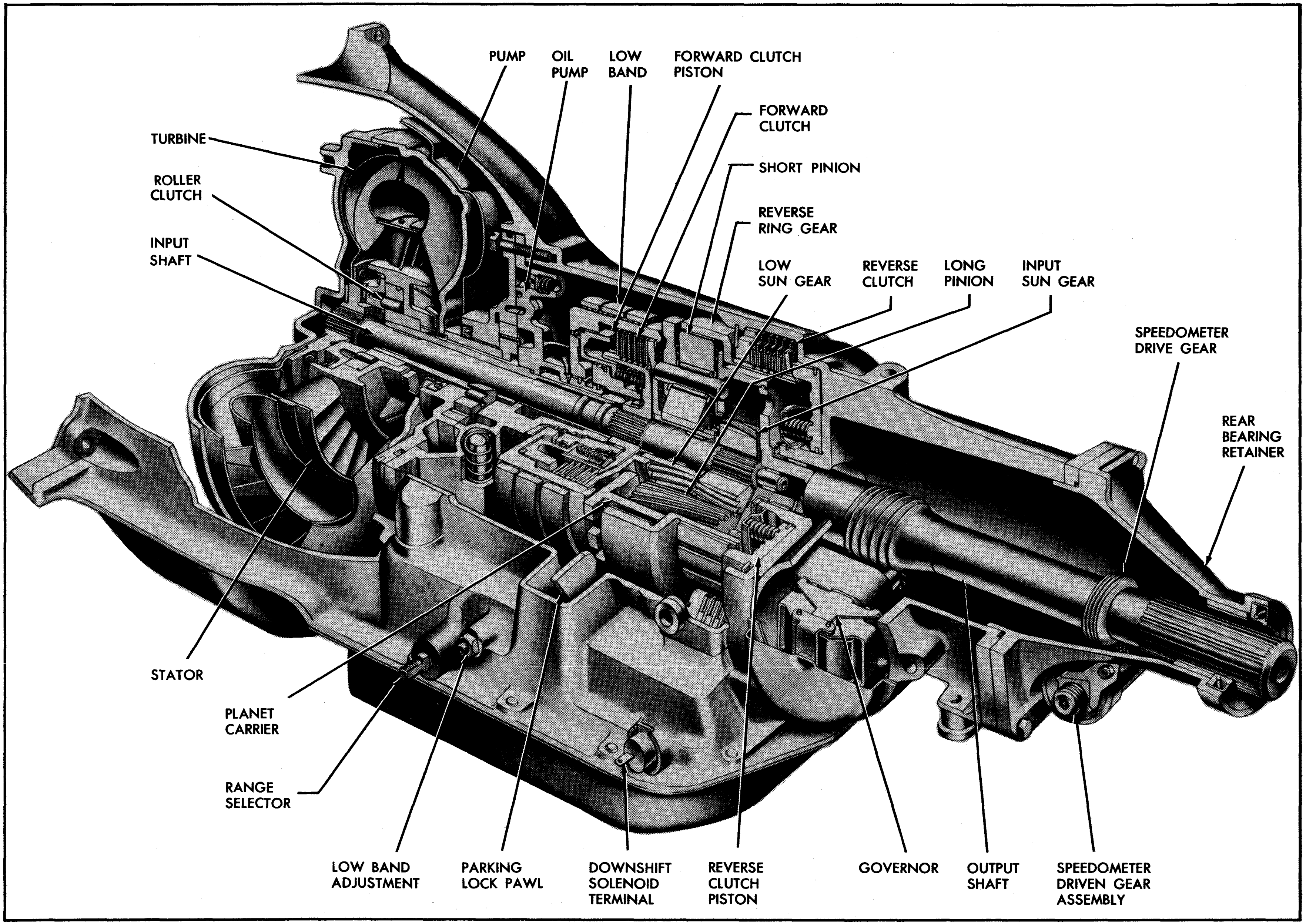



Fig. 7B-1 Cross Section of Pontiac Tempest Automatic Transmission

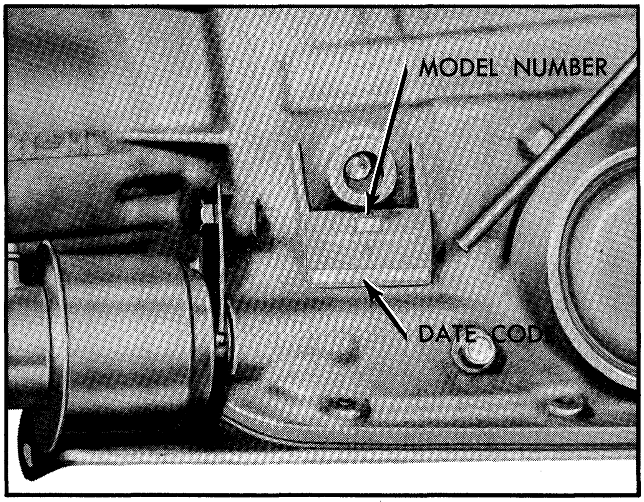



Fig. 7B-2 Transmission Name Plate

helping to drive the pump. Therefore, the total torque transmitted to the drive line is the combination of engine torque plus the additional torque supplied by the redirected oil striking the back side of the converter pump blades.

The stator is mounted on a roller clutch, which holds the stator from moving in a reverse direction when the unit is acting to multiply torque. As the turbine speed approaches pump speed, there is progressively less torque multiplication. The stator, which in the beginning was standing still, is picked up by the rapidly rotating oil and accelerates until the pump, turbine and stator are turning at almost the same speed. When the stator rotates, interference in the oil flow between the turbine and pump is minimized. When all three members are turning there is no torque multiplication in the converter and it is acting as a fluid coupling.

### OIL PUMP

A positive-displacement, internal-external gear type oil pump is used to supply oil to fill the converter, for application of forward and reverse clutches, for application and release of the low band, and to circulate oil for lubrication and heat transfer.

### PLANETARY GEAR SET AND CONTROLS

The planetary gear set consists of an input sun gear, low sun gear, short and long pinions, a reverse ring gear and a planet carrier. The input sun gear is splined to the input shaft. The low sun gear, which is part of the forward clutch assembly, rotates freely until the low band is applied. The input sun gear is meshed with three long pinions and the long pinions are meshed with three short pinions. The short pinions are meshed with the low sun gear and reverse ring gear. The input sun gear and short pinions always rotate in the same direction. Application of either the low band or the reverse clutch determines whether the output shaft rotates clockwise or counterclockwise.

### FORWARD CLUTCH

The forward clutch assembly consists of a drum, piston, coil springs, piston seals, and a clutch pack. These parts are retained inside the drum by the low sun gear and flange assembly and a snap ring. When oil pressure is applied to the piston, the clutch plates are pressed together connecting the clutch drum to the input shaft through the clutch hub. This engagement of the clutch causes the low sun gear to rotate with the input shaft.

### LOW BAND

The low band is a double-wrap steel band faced with a bonded lining which surrounds the forward clutch drum. The band is hydraulically applied by the low servo piston and released by spring pressure plus oil pressure.

### REVERSE CLUTCH

The reverse clutch assembly consists of a piston, inner and outer seal, cushion spring, coil springs, clutch pack, and reaction plate. These parts are retained inside the case by a snap ring. When oil pressure is applied to the piston, the clutch plates are pressed together holding the reverse ring gear stationary. This engagement of the clutch causes reverse rotation of the output shaft.

### GOVERNOR

The governor is located to the rear of the transmission case on the left side and is driven off the output shaft. The purpose of the governor is to generate a speed-sensitive modulating oil pressure that increases with car speed.

### VALVE BODY

The valve body assembly is bolted to the bottom of the transmission case and is accessible for service by removing the oil pan. The valve body assembly consists of a manual control valve, a shift valve, a modulator limit valve, a detent valve, and a high-speed downshift timing valve. The function of the valve body is to control application of the low band and clutches in response to governor and vacuum modulator pressure.

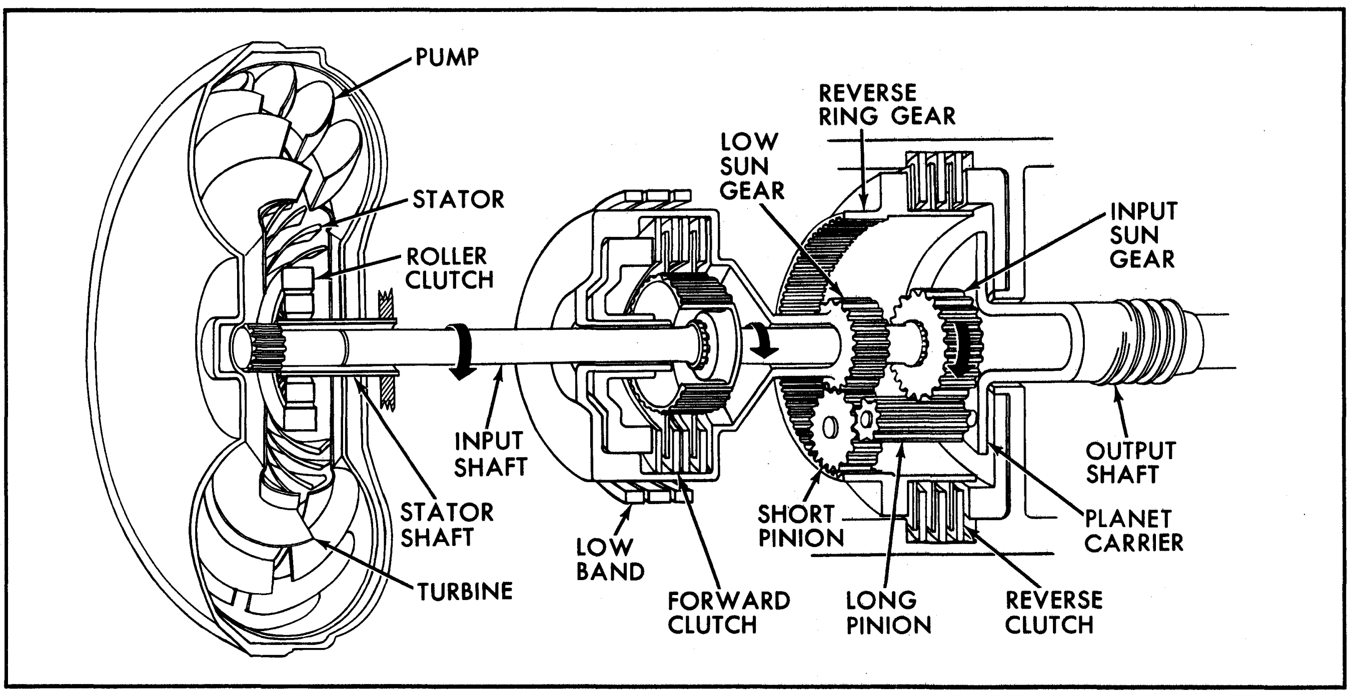



Fig. 7B-3 Power Flow - Neutral

## POWER FLOW

### *POWER FLOW—NEUTRAL (Fig. 7B-3)*

With the shift control lever in Neutral (N) position, the output shaft remains stationary. The clutches and low band are released, so there is no reaction member to provide positive drive. All gears are free to spin around their axis and no motion is imparted to the planet carrier.

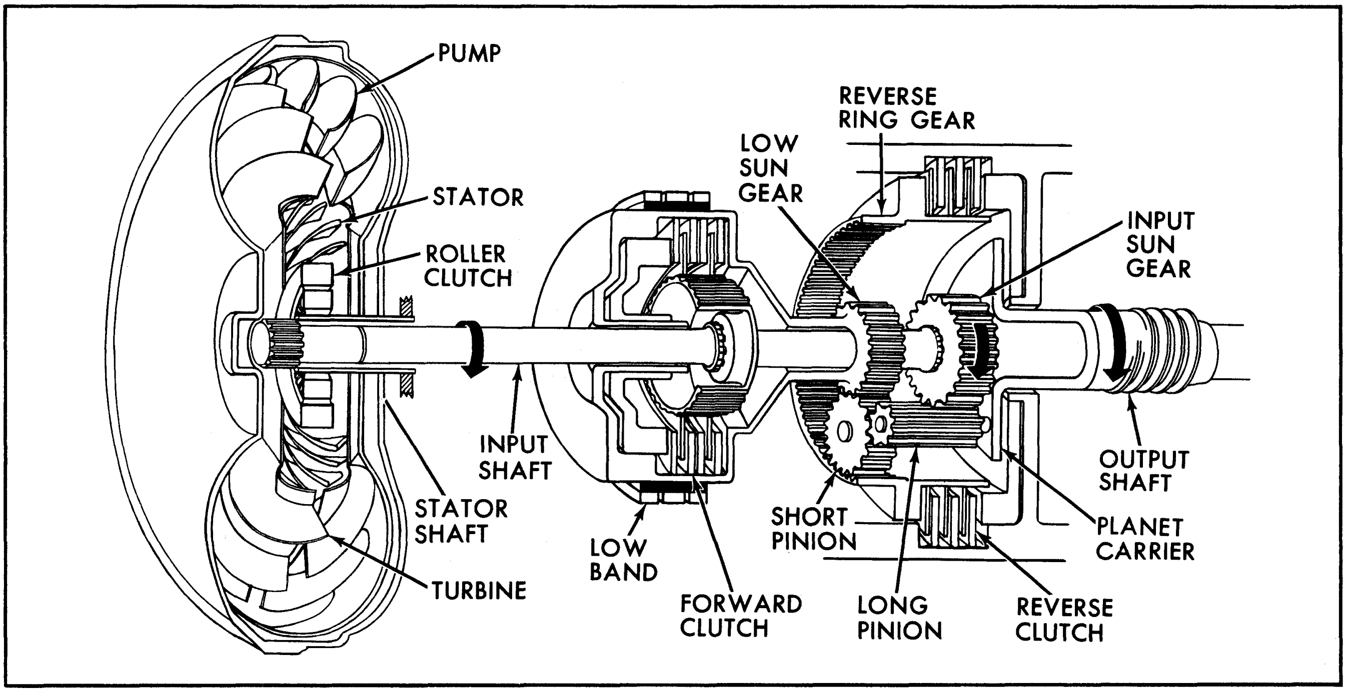



Fig. 7B-4 Power Flow - Low

***POWER FLOW—LOW (Fig. 7B-4)***

In Low (L) range the forward clutch is released and the low band is applied to the outside diameter of the forward clutch drum. With the low band applied, the low sun gear and flange assembly are held stationary. Drive is from the converter through the input shaft to the input sun gear in the planetary gear set. The input sun gear drives the long planet pinions, which are meshed with the short planet pinions. The short planet pinions are, in turn, meshed with the low sun gear. Since the low sun gear is held stationary with the low band applied, the short pinions walk around the low sun gear and carry with them the planet carrier and the output shaft at a reduction of 1.76 to 1.

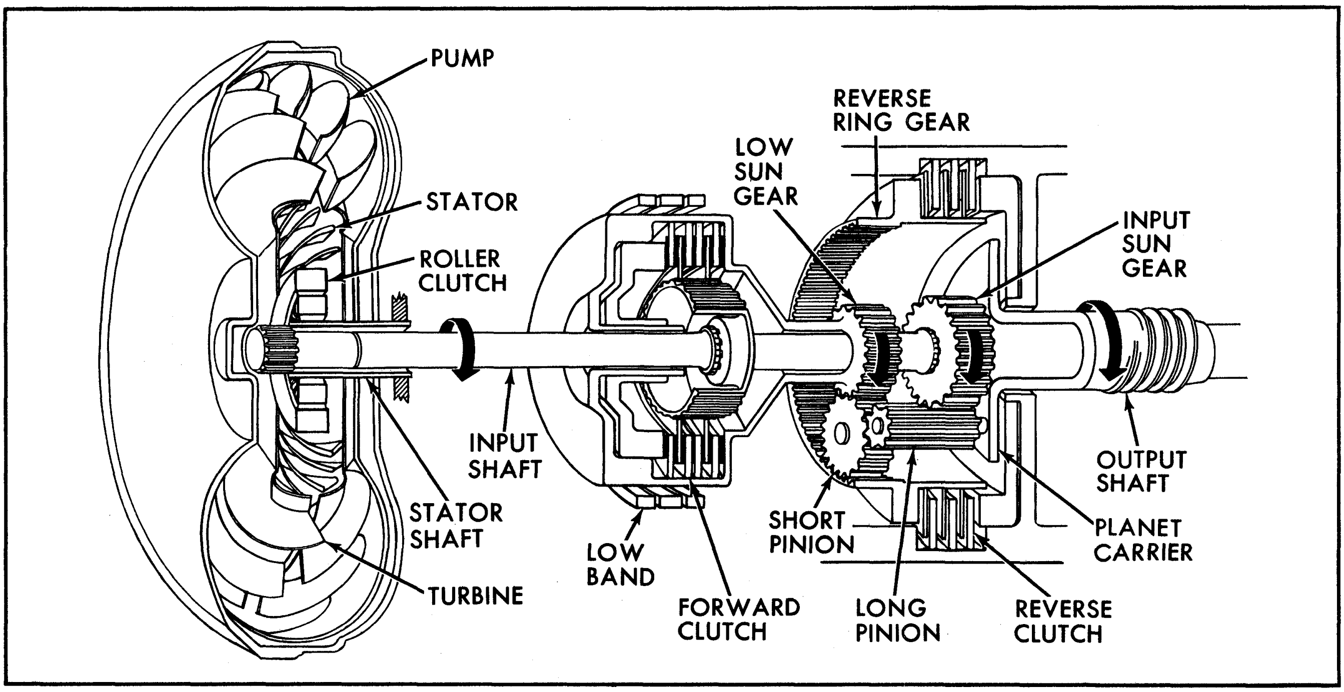



Fig. 7B-5 Power Flow - Direct Drive

***POWER FLOW—DIRECT DRIVE (Fig. 7B-5)***

With the manual control lever in Drive (D) position, the transmission is started automatically in low gear. When the upshift into direct drive occurs, the low band is released and the forward clutch is applied. With the forward clutch applied, the clutch hub, which is splined to the input shaft, is locked to the low sun gear and flange assembly through the clutch plates. The low sun gear is meshed with the short pinions, the short pinions are meshed with the long pinions, and the long pinions are meshed with the input sun gear which is also splined to the input shaft. Since both the low sun gear and input sun gear now rotate with the input shaft in the same direction, the entire planetary unit revolves at input shaft speed. Since the planet carrier is attached to the output shaft, the output shaft rotates at input shaft speed and in the same direction.

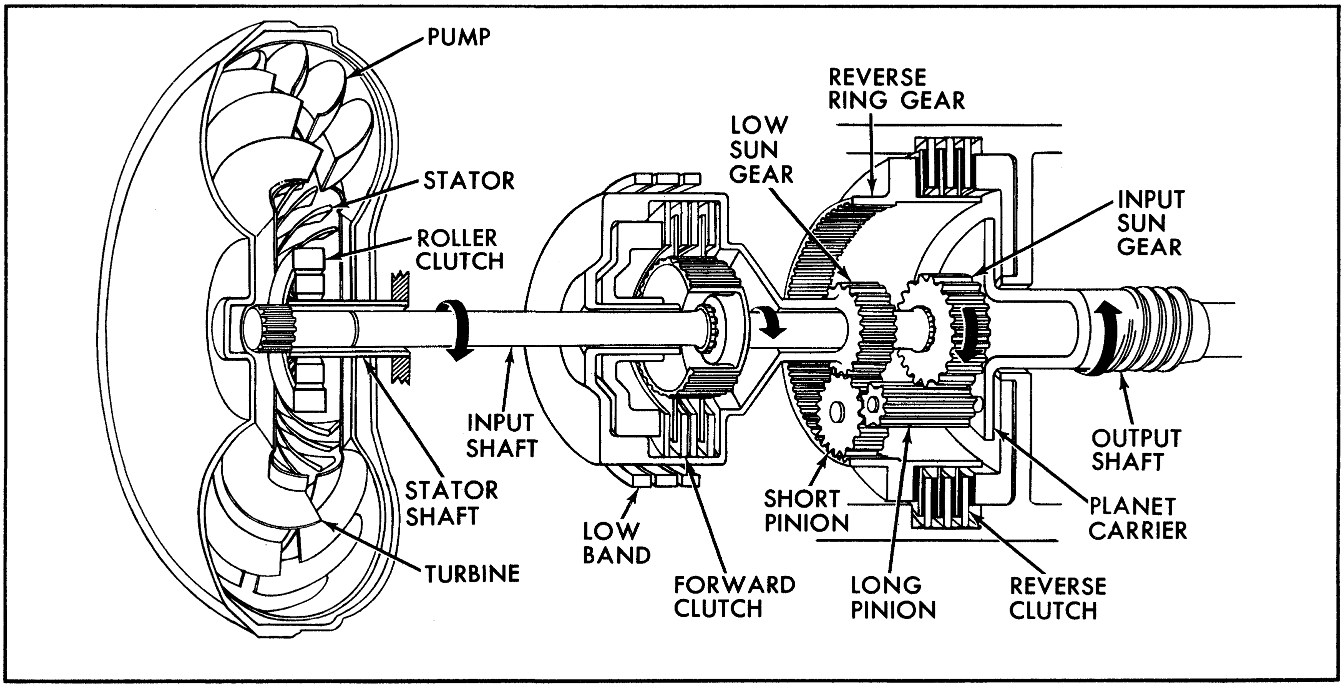



Fig. 7B-6 Power Flow - Reverse

## *POWER FLOW—REVERSE (Fig. 7B-6)*

When the manual control lever is in Reverse (R) position, the forward clutch and low band are released and the reverse clutch is applied, holding the reverse ring gear stationary. Drive is through the input shaft and input sun gear to the long pinions and then to the short pinions. The short pinions mesh with the reverse ring gear which is held stationary by the reverse clutch. The short pinions walk around the inside of the ring gear in a reverse direction, carrying with them the planet carrier and output shaft.

### OPERATION OF COMPONENTS IN PARK

In Park (P) position, all reaction members are released as in Neutral. A positive planet carrier lock is provided when the parking pawl is engaged with the heavy teeth spaced around the front face of the planet carrier (Fig. 7B-1). The linkage is actuated by manual action, but the parking pawl is activated by spring action. If the pawl is in line with a tooth of the planet carrier, rather than a space between teeth, the linkage remains in the Park position with the spring holding pressure against the pawl. Slight rotation of the planet carrier will immediately seat the pawl and lock the output shaft to the case.

## HYDRAULIC OPERATION

Hydraulic operation of the transmission is covered in three major sections: DEFINITIONS, CONTROL VALVES and CIRCUIT OPERATION. Circuit terminology is first defined and then the inputs and outputs of the control valves and the function of each valve are described. The last section describes circuit operation.

### DEFINITIONS

Circuit terminology used in describing hydraulic operation is defined as follows:

| | |
|---|---|
| Detent pressure | Wide open throttle (downshift solenoid energized) shift point control pressure derived from limited modulator pressure by the detent valve (see Detent Valve, page 7B-13). |
| Drive oil | Mainline pressure directed by the manual shift control valve to the control valves (see Manual Shift Control Valve, page 7B-9). |
| Governor pressure | Shift point control pressure derived from drive oil by the governor. Governor pressure is approximately proportional to car speed. Since it is derived from drive oil, it can never be higher than drive oil (mainline) pressure. (See Governor, page 7B-11). |
| Limited feed oil | A shift point control pressure that positions the modulator limit valve that, in turn, regulates the amount of pressure applied to the shift control valve. When the downshift solenoid is de-energized, limited feed oil is derived from vacuum modulator pressure. When the downshift solenoid is energized, limited feed oil is derived from drive oil. (See Modulator Limit Valve, page 7B-13 and Detent Valve, page 7B-13). |
| Limited modulator oil (pressure) | A shift point control pressure derived from limited feed (drive) oil by the modulator limit valve and applied to the shift control valve (see Modulator Limit Valve, page 7B-13). |
| Mainline oil (pressure) | Oil pump output pressure controlled by the main pressure regulator valve (see Main Pressure Regulator Valve, page 7B-9). |

| | |
|---|---|
| Modulator oil (pressure) | A "feedback" pressure derived from mainline pressure by the vacuum modulator and applied to the main pressure regulator boost valve to modulate (control) mainline pressure (see Vacuum Modulator, page 7B-10, and Main Pressure Regulator Valve, page 7B-9). |
| Low boost (Modulator boost) | Drive oil directed by the manual shift control valve to the vacuum modulator to increase modulator pressure in Low range and directed to the shift valve to keep it in the downshift (low) position (see Manual Shift Control Valve, page 7B-9 and Shift and Shift Control Valve, page 7B-12). |
| Reverse boost | Drive oil directed by the manual shift control valve to the main pressure regulator boost valve to increase mainline pressure in Reverse range (see Manual Shift Control Valve, page 7B-9). |

## CONTROL VALVES

*NOTE: With regard to control valve inputs and outputs, the terminology of an output oil pressure may differ from that of the input. Although the pressure is the same, functional terminology is used to facilitate description of hydraulic operation. For example, "detent pressure" and "limited modulator pressure" are the same but when the term "detent pressure" is used it is understood to be the pressure in the circuit between the detent valve and the shift control valve that causes a forced downshift.*

Definitions for the hydraulic terminology used in the following paragraphs are found under DEFINITIONS above.

MANUAL SHIFT CONTROL VALVE (Fig. 7B-7)

Input: Mainline pressure

Outputs: Drive oil to governor, shift valve, detent valve, high speed downshift timing valve, and low servo
Reverse oil to reverse clutch and pressure regulator boost valve
Low boost oil to shift valve and vacuum modulator

The manual shift control valve in the valve body routes drive oil to the controlling devices that govern operation in Drive, Low and Reverse. In Neutral, Park and Reverse ranges, the manual control valve cuts off drive oil to the low servo and forward clutch. The manual shift control valve is connected by mechanical linkage to the manual control lever operated by the driver.

MAIN PRESSURE REGULATOR VALVE (Fig. 7B-8)

Inputs: Oil pump output
Reverse boost
Modulator oil

Outputs: Converter feed and lubrication oil and mainline pressure.

The main pressure regulator valve, which is located in the pump body, is used as the basic control of hydraulic pressure within the transmission.

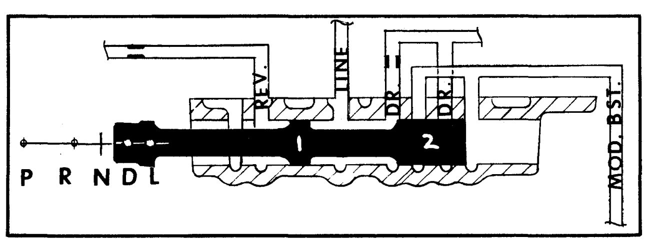



Fig. 7B-7 Manual Shift Control Valve

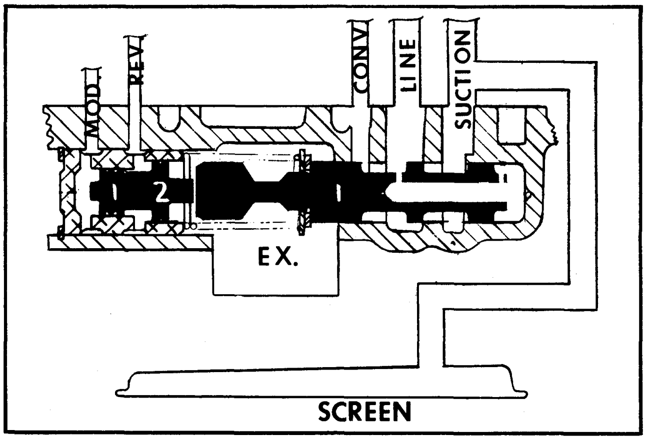



Fig. 7B-8 Main Pressure Regulator Valve - At Idle

MAIN PRESSURE REGULATOR VALVE (Fig. 7B-8) (Cont.)

When the engine is idling or has just been started, oil enters the main pressure regulator valve assembly between the first and second lands and flows through interconnecting drilled holes in the valve to occupy the space between the third land and the oil pump body (Fig. 7B-8). Oil under pressure between the third land and the pump body moves the valve against its spring to uncover the port which directs oil to the converter and thence to the oil cooler (V-8 only) and lubrication systems of the transmission.

As higher engine speeds are attained, the volume of oil leaving the pump increases until the valve moves to a position that opens a port to allow the proper amount of mainline oil to escape to suction to regulate pressure (Fig. 7B-9).

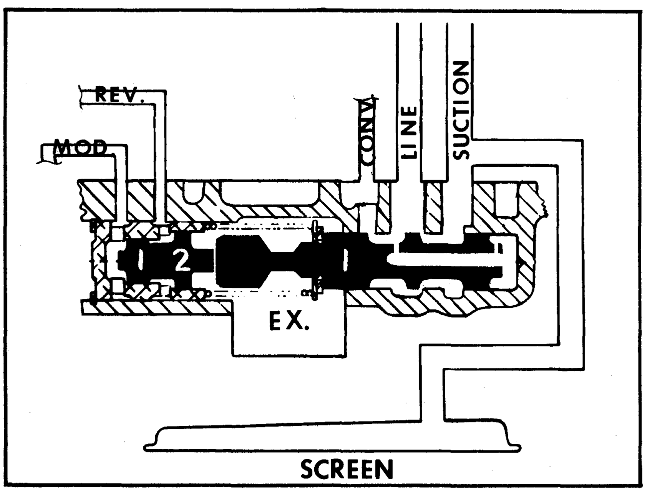



Fig. 7B-9 Main Pressure Regulator Valve - Typical Position

***Boost Valve***

A boost valve at the spring end of the pressure regulator valve functions to raise mainline pressure when necessary by adding hydraulic pressure to the spring pressure on the main pressure regulator valve.

***Modulator Boost***

With the manual shift control valve in Drive (D) position, modulator pressure varied by operating conditions is directed to the space between the first land of the boost valve and the boost valve sleeve. Oil pressure in this space has the same effect as increasing the spring pressure against the pressure regulator valve, thus it increases mainline oil pressure.

***Reverse Boost***

With the manual shift control valve in Reverse (R) position, oil pressure is directed to the space between the first and second lands of the boost valve. Since the second land is larger than the first, the boost valve bears on the spring end of the pressure regulator valve, adding to the spring pressure of the valve and increasing mainline oil pressure for operation in reverse range.

VACUUM MODULATOR (Fig. 7B-10)

Inputs: Mainline pressure
Low boost
Governor pressure

Output: Modulator oil

The vacuum modulator and valve assembly translates load (engine manifold vacuum), barometric

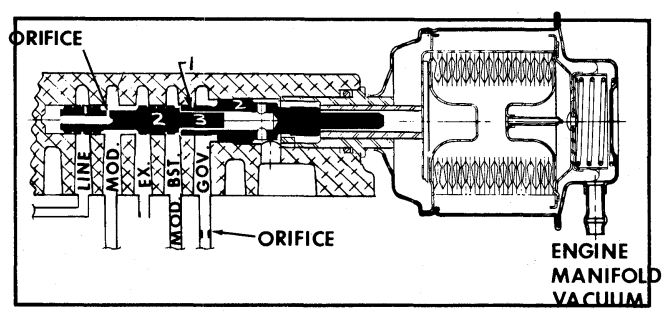



Fig. 7B-10 Vacuum Modulator and Valve Assembly

pressure (altitute) and speed (governor pressure) into modulated oil pressure to regulate mainline oil pressure at an efficient value.

Mainline oil enters between the first and second lands of the valve and flows through the drilled ports to the space between the first land and the valve body. When it reaches sufficient pressure, the oil moves the valve against the modulator assembly load to regulate the exit oil (modulator oil).

#### *Manifold Vacuum Effect*

The modulator assembly is housed in a sealed container so that engine manifold vacuum acts upon it to reduce the load against the valve and thus affect modulator pressure. Conditions of load or grade that lower manifold vacuum increase modulator pressure, while high manifold vacuum decreases modulator pressure.

*NOTE: Fig. 7B-10 shows the valve assembly all the way to the right. This is the position of the valve assembly when manifold vacuum is high and mainline pressure is low.*

#### *Altitude or Barometric Pressure Effect*

If the car is operated at high altitudes where barometric pressure is reduced, the aneroid device in the vacuum modulator housing expands to reduce modulator load on the valve in proportion to the barometric pressure.

At high altitudes engine output is reduced and comparable reduction in transmission mainline oil pressure is necessary to accomplish smooth shifts.

#### *Governor Effect*

As car speed increases, governor pressure increases. Governor pressure bearing on the fourth land of the vacuum modulator valve has the effect of reducing the modulator assembly load against the valve assembly, thereby reducing modulator oil pressure as governor pressure (car speed) increases.

#### *Low (Modulator) Boost Effect*

With the manual shift control valve in Low (L) position, mainline pressure bears against the second land of the modulator valve, separating the two parts of the valve assembly and moving the left (front) valve to the bottom of its bore independent of the modulator load. Thus, modulator pressure is directed to the main pressure regulator boost valve to provide an increase in mainline pressure in low range regardless of engine vacuum. However, if driving conditions result in low engine vacuum, the modulator load will move the two sections of the valve back together. Under these conditions both the modulator assembly and the pressure of mainline oil against the second land of the valve will regulate modulator oil pressure.

GOVERNOR (Fig. 7B-11)

Input: Drive oil

Output: Governor pressure

The governor assembly contains a pressure regulator valve, the output of which is determined by car speed acting through the centrifugal force of a pair of dual weights, the inner pair of which is spring loaded.

As the car begins to move, the weight assemblies move outward to provide a regulating force against the valve through the springs between the primary and secondary weights. As a car speed is further increased, regulating force against the valve is

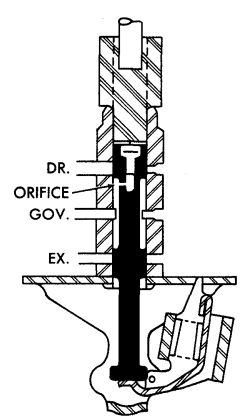



Fig. 7B-11 Governor

provided by the secondary weights moving outward. At approximately 35 MPH the primary weights have reached the limit of their travel and the force against the valve is then entirely through the secondary weights and the spring. Governor pressure is determined at very low speeds by the primary weights, and at higher speeds by the secondary weights.

Regulated oil from the governor is directed to the shift valve, vacuum modulator valve, modulator limit valve and high speed downshift timing valve.

Governor pressure determines or affects shift points, mainline oil pressure and downshift timing.

SHIFT VALVE AND SHIFT CONTROL VALVE

Inputs: Drive oil
Governor pressure
Limited modulator oil
Detent pressure
Low boost

Output: Drive oil (clutch apply and low band release)

The shift valve and shift control valve in the valve body react to oil pressure controlled by the governor and the vacuum modulator to shift the transmission from low to high gear or from high gear to low gear.

#### *Upshift From Automatic Low to Direct Drive*

As the car is accelerated from a stop, the shift valve and shift control valve are positioned as shown in Fig. 7B-12. The shift valve is held against the end of its bore by the force of a spring and the pressure exerted on the second (during wide open throttle

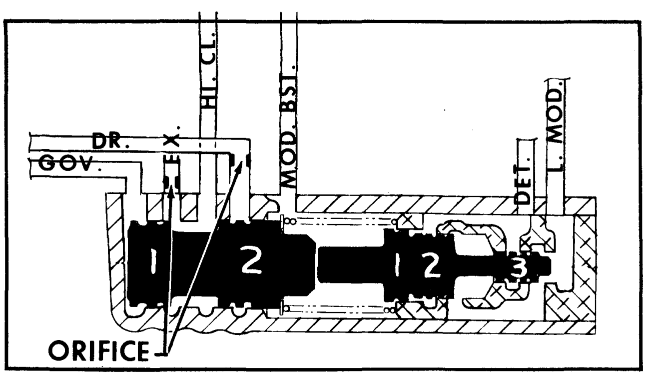



Fig. 7B-12 Shift Valve and Shift Control - Low

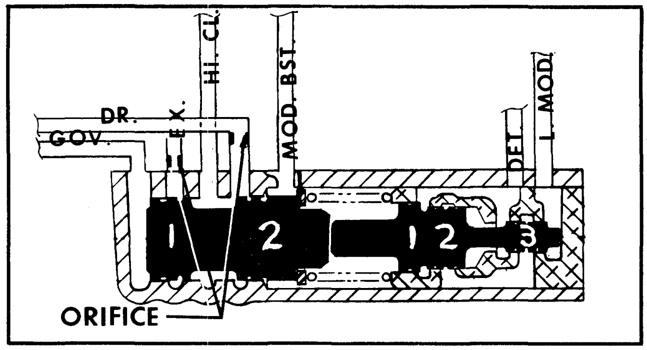



Fig. 7B-13 Shift Valve and Shift Control Valve - High

only) and third lands of the shift control valve. With the shift valve thus positioned, no drive oil is directed to the high clutch piston or the spring side of the low servo piston, thus the low band is applied and the transmission is in low gear.

When the proper relationship between car speed and throttle opening exists, governor pressure against the first land of the shift valve will overcome the spring pressure and the force of limited modulator oil pressure against the shift regulator valve and move both valves to the right as shown in Fig. 7B-13. With the shift valve thus positioned, drive oil is directed to the forward clutch piston and the spring side of the low servo piston.

With the shift control valve positioned to the right, limited modulator pressure is bearing only on the third land of the valve. With limited modulator oil pressure bearing only on the third land of the shift control valve, a greater throttle opening (providing greater limited modulator pressure) is necessary to cause a downshift than was required to allow an upshift at a given car speed.

#### *Downshift From Direct Drive to Low Gear*

When limited modulator pressure against the third land of the shift regulator valve in combination with the shift valve spring reaches a value sufficient to overcome governor pressure against the first land of the shift valve, both valves move to the shift shifted by cutting off drive oil to the high clutch and the spring side of the low servo piston.

#### *Forced Downshift From Direct Drive to Low Gear*

During a forced downshift, detent pressure is applied to the first and second lands of the shift control valve. The addition of detent pressure to limited modulator pressure on the third land plus the shift

valve spring is enough to overcome governor pressure and cause a downshift.

### *Manual Low*

With the manual control lever in Low (L) position, low boost pressure is directed to the space between the shift valve and the shift control valve (Fig. 7B-14). Low boost pressure in this space adds to the shift valve spring pressure and moves the shift valve to the end of its bore. With the shift valve thus positioned, no drive oil is directed to the high clutch piston or the spring side of the low servo piston, thus the low band is applied and the transmission is in low range.

*NOTE: Governor pressure can never become high enough to cause an upshift in Low (L) range.*

DETENT VALVE (Fig. 7B-15)

Inputs: Modulator oil
Limited modulator oil (downshift solenoid de-energized)
Drive oil (downshift solenoid energized)

Outputs: Limited feed oil (limited modulator oil with downshift solenoid de-energized; drive oil with solenoid energized)
Detent pressure (with solenoid energized)

The detent valve is a solenoid-operated, two-position valve that provides a downshift at wide open throttle if car speed if low enough.

Electrical contacts on the carburetor linkage energize the detent solenoid as wide open throttle is reached. Energization of the solenoid retracts its

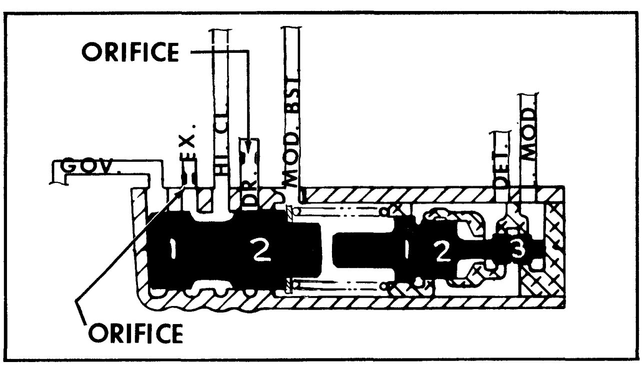



Fig. 7B-14 Shift Valve and Shift Control Valve - Manual Low

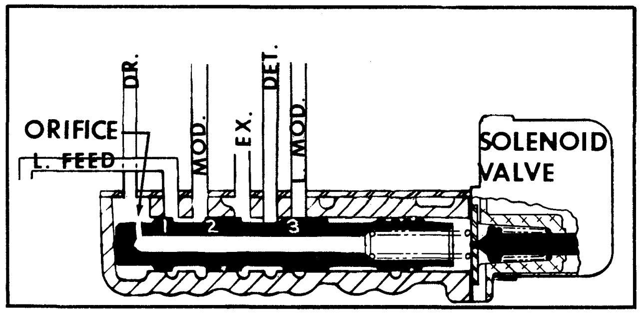



Fig. 7B-15 Detent Valve - Solenoid De-energized

plunger and allows oil from the center of the valve to flow to exhaust. Drive oil against the first land and end of the valve moves the valve against its spring (Fig. 7B-16).

With the valve in this position ports are opened to allow drive oil (limited feed oil) to flow to the modulator limit valve and limited modulator oil (detent oil) to flow to the detent port of the shift control valve.

When the solenoid is de-energized, the spring loaded plunger seals the exhaust port. Drive oil then occupies the center of the valve and bears against the fifth land of the valve as well as the first land. The detent valve spring then moves the valve to shut off the detent port.

MODULATOR LIMIT VALVE (Fig. 7B-17)

Inputs: Limited feed oil (see Detent Valve outputs above)
Governor pressure

Output: Limited modulator oil

The function of the modulator limit valve is to provide limited modulator pressure for wide open throttle shift point control that is not affected by altitude.

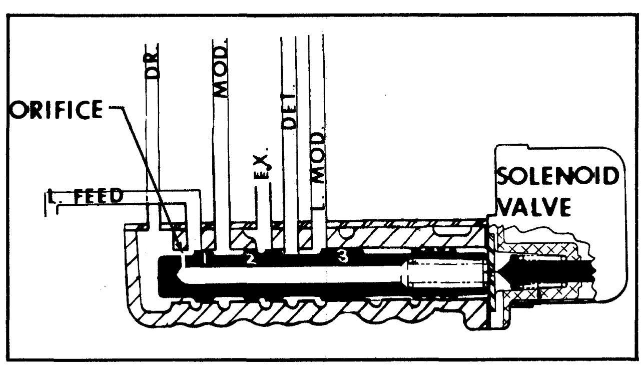



Fig. 7B-16 Detent Valve - Solenoid Energized

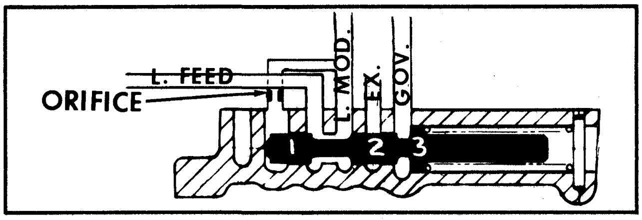



Fig. 7B-17 Modulator Limit Valve - Low Speed

The modulator limit valve regulates limited feed oil (mainline pressure) routed through the detent valve to provide decreasing oil pressure bearing against the second and third lands of the shift control valve as car speed increases. This decrease in oil pressure is accomplished in part by governor valve pressure on the third land of the valve acting to decrease spring pressure as car speed (governor pressure) increases (Fig. 7B-18). While governor pressure is exerted on the third land, limited modulator pressure is directed to the area between the first land and the valve body, compressing the valve spring. The combined force of governor pressure and limited modulator pressure moves the valve to the right, reducing the opening through which oil flows to the shift control valve. Thus limited modulator pressure substitutes for the modulator pressure controlled by the vacuum modulator and routed through the detent valve when the detent valve is to the left (solenoid de-energized).

The modulator limit valve is in operation only during wide open throttle operation with the manual shift control valve in Drive (D) position.

HIGH SPEED DOWNSHIFT TIMING VALVE (Fig. 7B-19)

Inputs: Governor pressure
Drive oil

Output: Drive oil (band apply)

The high speed downshift timing valve is a spring loaded valve located in the valve body. Its

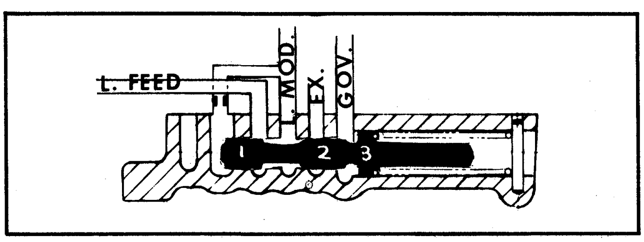



Fig. 7B-18 Modulator Limit Valve - Wide Open Throttle

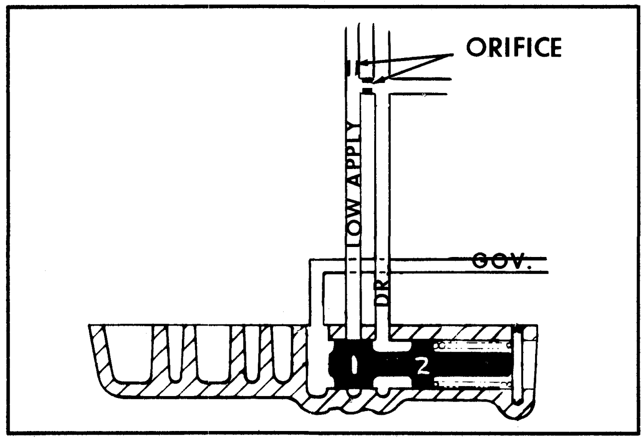



Fig. 7B-19 High Speed Downshift Timing Valve - High Speed

function is to control the rate of low servo application at high road speeds.

At sufficiently high road speeds, governor pressure against the first land of the valve overcomes spring pressure to move the valve to the position shown in Fig. 7B-19. With the valve in this position, oil for low servo application must pass through two orifices as shown. At lower car speeds, governor valve pressure is not sufficient to overcome the spring pressure and low servo application is made through passages containing only one orifice as shown in Fig. 7B-20. Because the orifices restrict the flow of oil, when the oil must pass through two orifices at higher car speeds, the low band is not applied as rapidly as at lower speeds when the oil must pass through only one orifice. This slight delay in band application gives the engine an instant to speed up after the clutch is released and before the low band is applied.

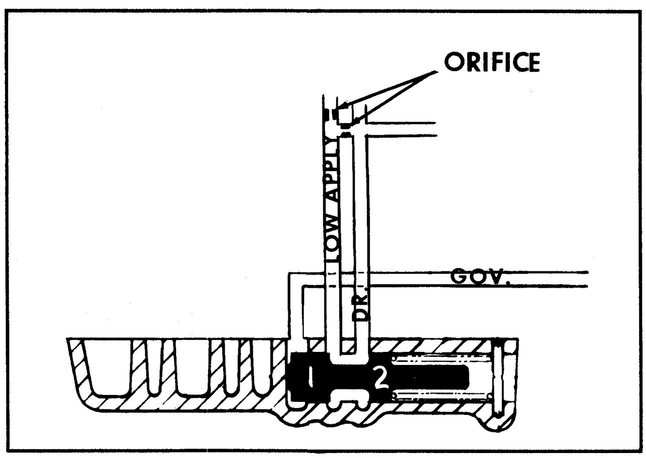



Fig. 7B-20 High Speed Downshift Timing Valve - Low Speed

COOLER BY-PASS AND LUBE BLOW-OFF CHECK VALVES (Fig. 7B-21)

If the cooler system (radiator or lines) becomes restricted, the cooler by-pass check valve unseats to allow oil to flow directly to the lubrication system passages. The lube blow-off check valve functions to regulate the pressure applied to the lubrication system.

## *CIRCUIT OPERATION*

For terminology definitions and detailed description of the operation of individual valves, refer to DEFINITIONS and CONTROL VALVES above.

NEUTRAL (Fig. 7B-21)

In Neutral (N) the manual shift control valve is positioned as shown in Fig. 7B-21. When the engine is running, regulated mainline pressure is applied to the manual shift control valve and the vacuum modulator. Converter feed and lubrication oil are applied from the main pressure regulator valve to the converter feed and lubrication circuits.

DRIVE RANGE - UPSHIFTED (Fig. 7B-22)

In Drive (D) the manual shift control valve is positioned as shown in Fig. 7B-22. With the engine running and the car standing still, drive oil is directed from the manual shift control valve to

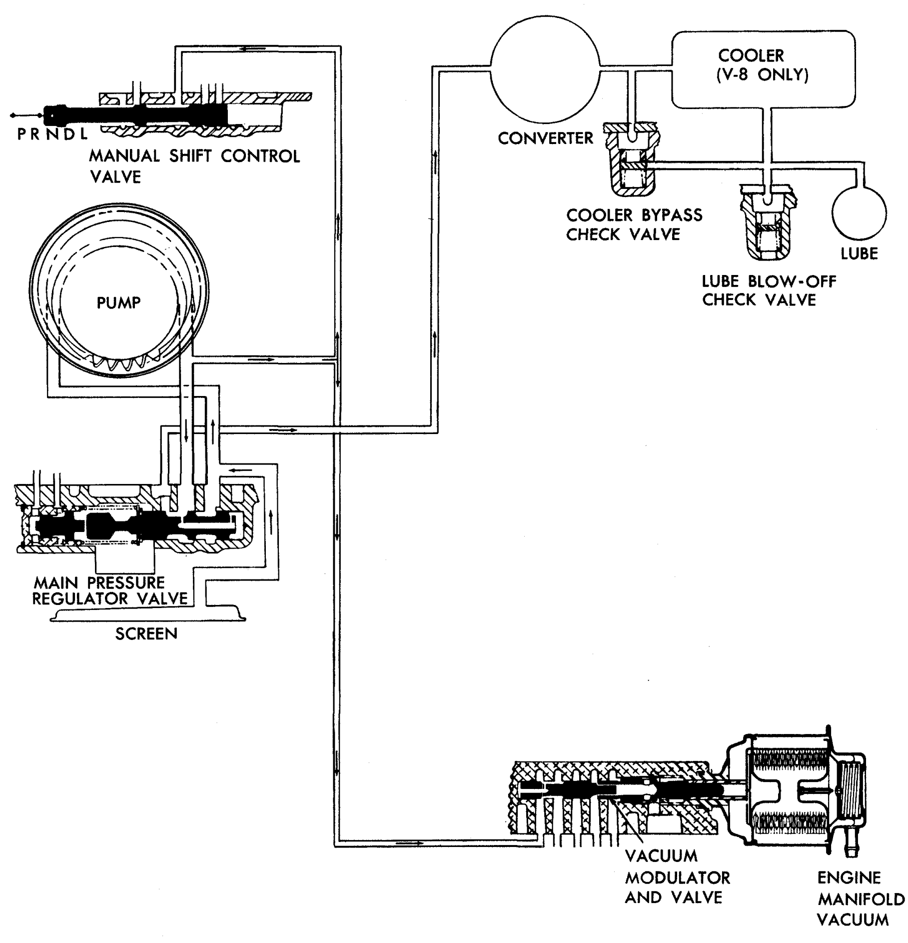



Fig. 7B-21 Oil Circuits - Neutral

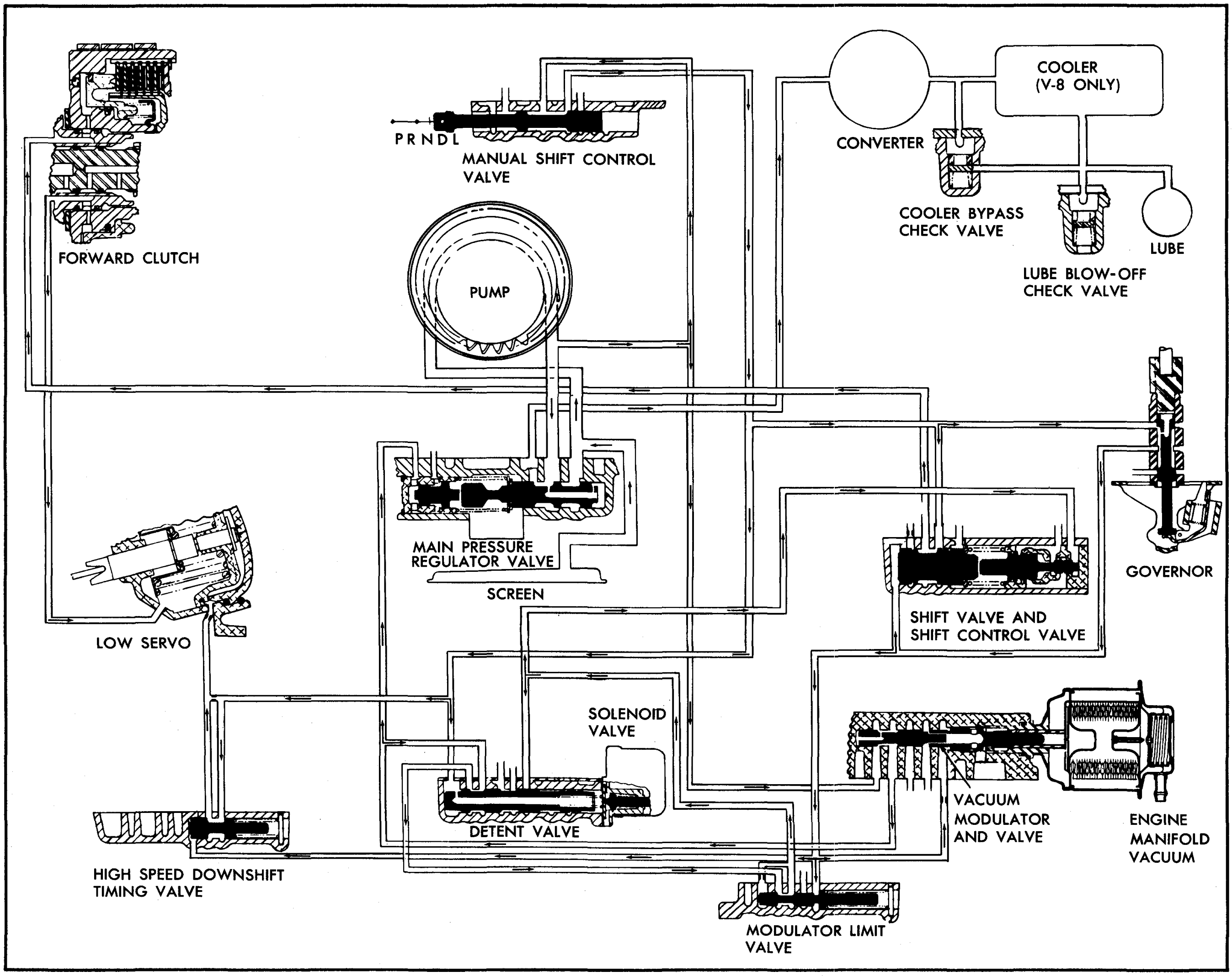



Fig. 7B-22 Oil Circuits - Drive Range (Upshifted)

the governor, shift valve, detent valve, and low servo. With drive oil applied to the low servo, the low band is applied and the transmission is in automatic low.

When the throttle is opened for a normal start, engine manifold vacuum drops and the vacuum modulator reacts to apply modulator oil to the detent valve and to the main pressure regulator boost valve to increase mainline pressure. Modulator oil entering the detent valve leaves as limited feed oil, which is applied to the modulator limit valve where it becomes limited modulator oil applied to the shift control valve.

When the car begins to move, governor pressure begins to build up and is applied to the shift valve, vacuum modulator, modulator limit valve, and the high speed downshift timing valve. As car speed increases, governor pressure increases, and governor pressure applied to the vacuum modulator acts to reduce modulator load, assisting engine manifold vacuum and reducing mainline pressure by reducing the modulator oil pressure applied to the main pressure regulator boost valve.

When the proper relationship exists between engine manifold vacuum and car speed, governor pressure overcomes the combined forces of the shift valve spring and limited modulator oil applied to the shift control valve and the shift valve moves to the right. When the shift valve moves to the right, drive oil from the shift valve applies the forward clutch and releases the low band, and the transmission is in direct drive.

During a wide open throttle start, limited feed oil is derived from drive oil because the downshift

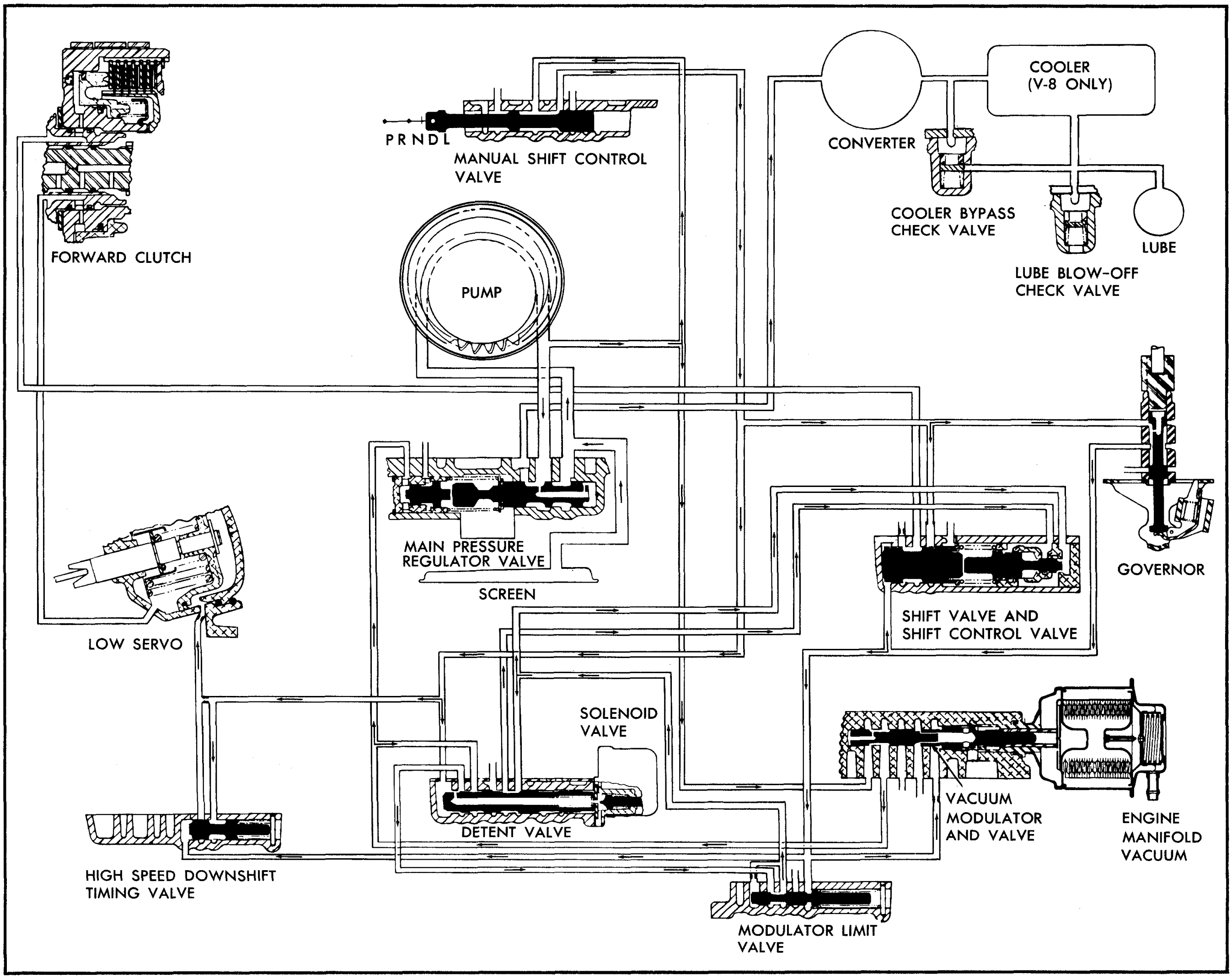



Fig. 7B-23 Oil Circuits - Drive Range (Downshifted)

solenoid is energized, allowing the detent valve to move to the right and direct drive oil into the limited feed passage. Since limited feed oil pressure derived from drive oil is higher than when derived from modulator oil, the modulator limit valve will move to the right, regulating limited modulator oil against the modulator limit valve spring. Therefore, during a wide open throttle upshift or downshift, the effect of altitude on the shift point is eliminated since the limited modulator oil pressure applied to the shift control valve is regulated by the modulator limit valve spring, which is unaffected by altitude.

DRIVE RANGE - DOWNSHIFTED (Fig. 7B-23)

At speeds below approximately 60 MPH, a forced downshift in Drive range is possible by depressing the accelerator to wide open throttle to actuate the downshift switch and energize the downshift solenoid, allowing the detent valve to move to the right.

When the detent valve moves to the right, drive oil enters the limited feed circuit to the modulator limit valve and leaves the modulator limit valve as limited modulator oil. This limited modulator oil is applied to the second and third lands of the shift control valve and to the detent valve. Limited modulator oil enters the detent valve and leaves as detent oil, which is applied to the first land of the shift control valve. The combined forces of limited modulator oil, detent pressure, and shift valve spring are sufficient to overcome governor pressure and move the shift valve to the left, downshifting the transmission by releasing the forward clutch and applying the low band.

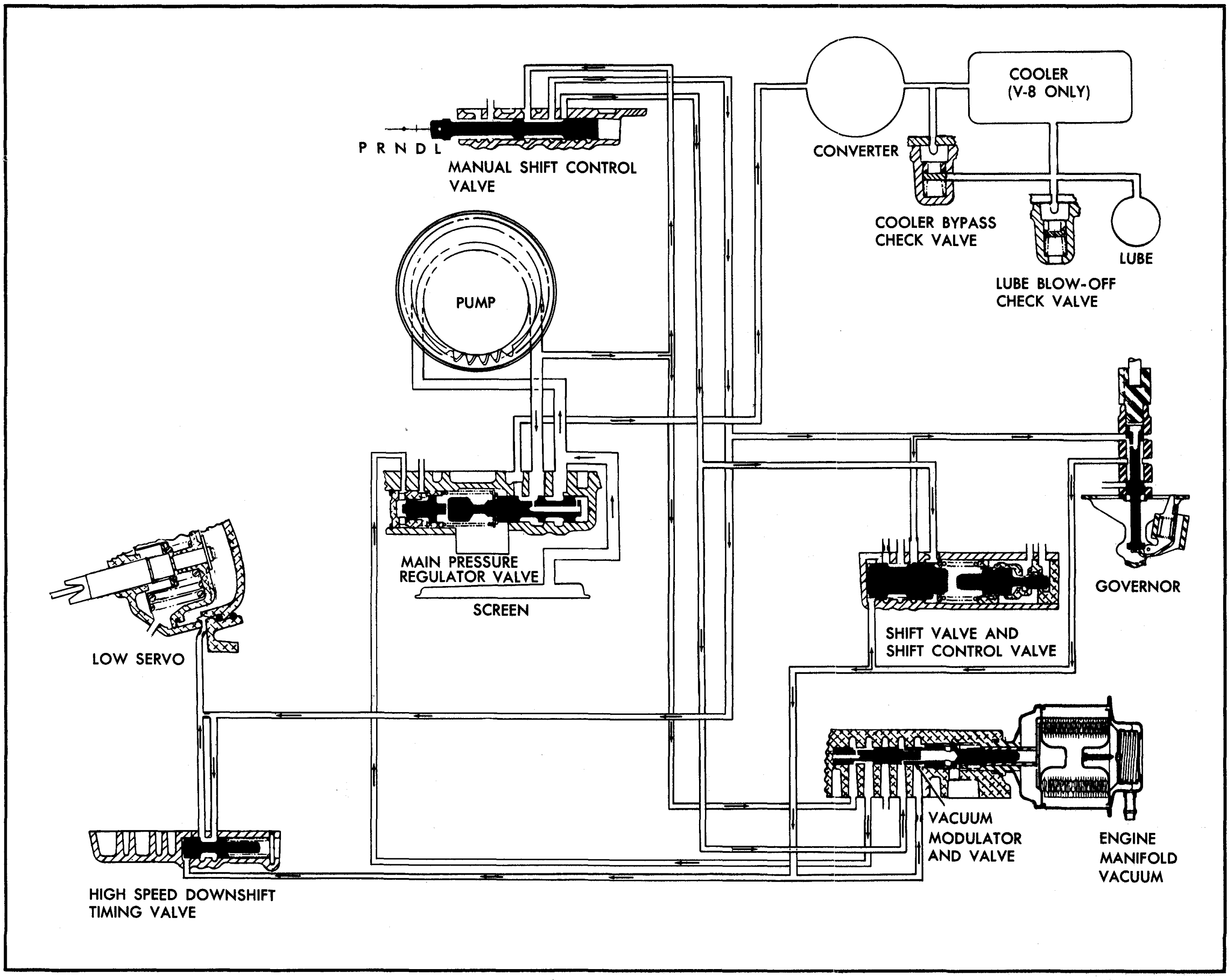



Fig. 7B-24 Oil Circuits - Manual Low

If the forced downshift is accomplished at a high enough speed, governor pressure is high enough to move the high speed downshift timing valve all the way to the right. When this valve is all the way to the right, drive oil to the low servo must pass through a restricted orifice because the unrestricted circuit through the high speed downshift timing valve is blocked. Under these conditions application of the low band is delayed enough to assure full release of the forward clutch and a slight increase in engine speed before the downshift is completed.

MANUAL LOW (Fig. 7B-24)

In Low (L) range the manual shift control valve is positioned as shown in Fig. 7B-24. With the manual shift control valve in this position, mainline oil is directed as low boost oil to the vacuum modulator and the shift valve.

Low boost oil applied to the right end of the shift valve and the force of the shift valve spring keep the shift valve in the downshift position regardless of governor pressure. Low boost oil applied to the vacuum modulator increases modulator pressure, which is applied to the main pressure regulator boost valve to raise mainline pressure. Increased mainline pressure (drive oil) applied to the low servo assures that the low band will not slip under the load conditions encountered when Low range operation is required.

REVERSE (Fig. 7B-25)

In Reverse (R) range the manual shift control valve is positioned as shown in Fig. 7B-25. With the manual shift control valve in this position, mainline pressure is directed to the reverse circuit to apply the reverse clutch and to boost mainline pressure

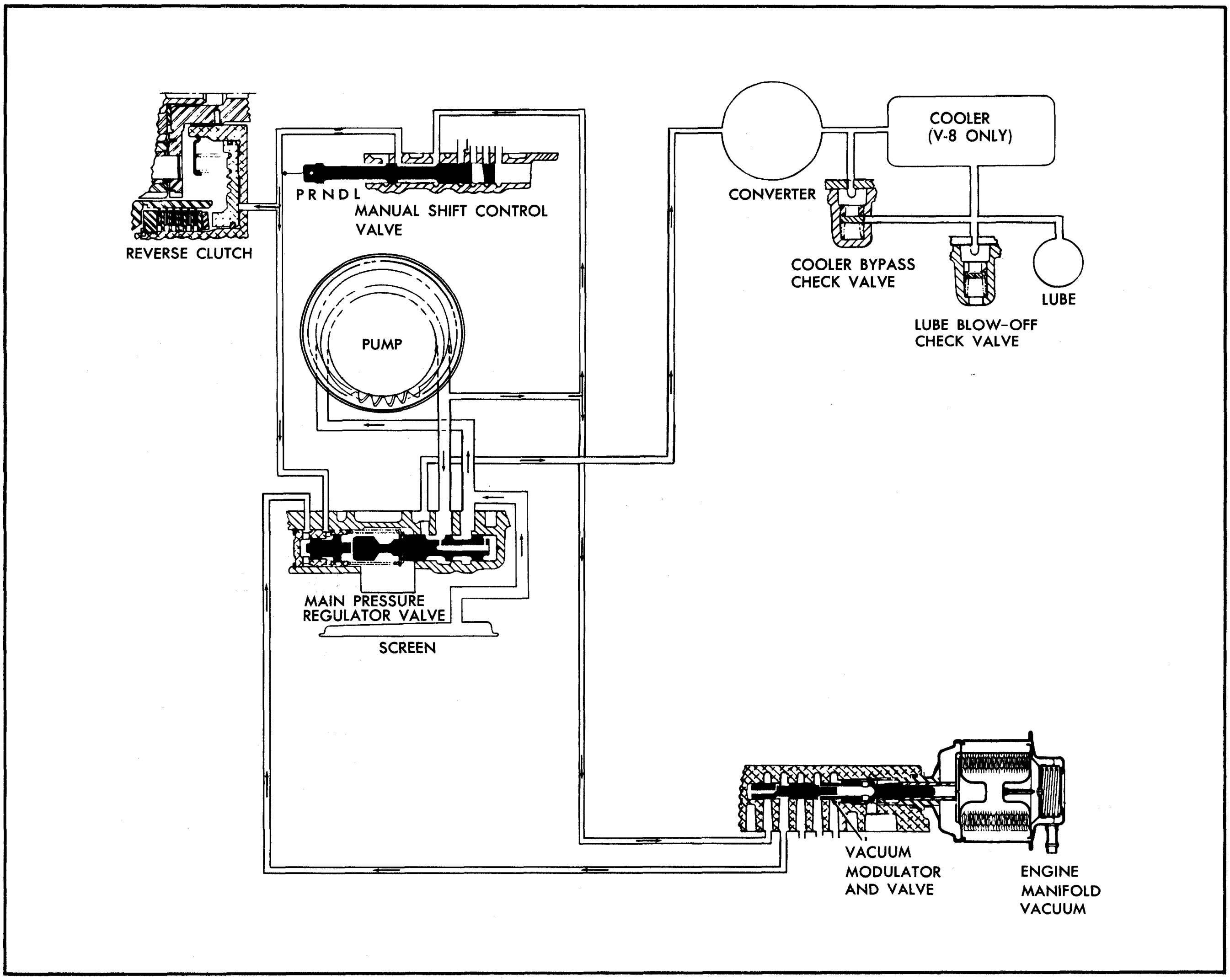



Fig. 7B-25 Oil Circuits - Reverse

by adding to the modulator oil applied to the main pressure regulator boost valve.

## MAINTENANCE AND ADJUSTMENTS

### *OIL RECOMMENDATIONS*

It is important to use only Automatic Transmission Fluid (Type A). This is an all-season fluid, ideal for year-round operation. No special additives to these fluids are required or recommended.

Instructions for checking fluid level and for draining and refilling the transmission follow:

### *OIL LEVEL*

The transmission oil level should be checked every 6,000 miles. Oil should be added only when the level is near the ADD mark on the indicator (Fig. 7B-26) with oil at normal operating temperature. The oil level indicator is located in the engine compartment (Fig. 7B-27).

*NOTE: The difference in oil level between Full and ADD is one (1) pint.*

To check oil level accurately, the car should be level, the engine should be idled with the transmission oil at normal temperature, and the control lever in Park (P) position.

It is important that the oil level be maintained no higher than the FULL mark on the transmission oil level indicator. DO NOT OVERFILL, for when the oil level is at the full mark on the oil level indicator, it is just slightly below the planetary gear unit. If oil is added which brings the oil level above the full

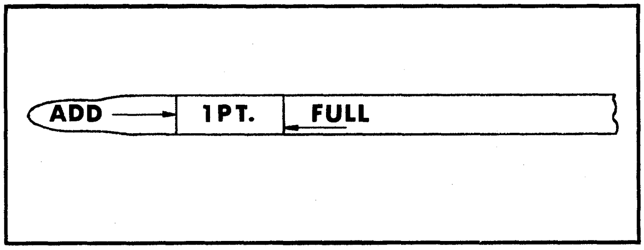



Fig. 7B-26 Oil Level Indicator

mark, the planetary unit will run in the oil, foaming and aerating the oil. This will cause malfunctioning of the transmission assembly due to improper application of the band or clutches and excessive temperature.

If the transmission is found to be consistently low on oil, a thorough inspection should be made to find and correct all external oil leaks. All mating surfaces, such as the oil pan rail, filler tube, governor and modulator should be carefully examined for signs of leakage. The modulator must also be checked to insure that the diaphragm has not ruptured as this would allow transmission oil to be drawn into the intake manifold. Usually, the exhaust will be excessively smoky if the diaphragm ruptures, due to transmission oil drawn into the combustion chambers.

### DRAINING AND REFILLING

Draining of the transmission oil at 24,000 mile intervals is recommended. Drain the oil by removing the oil pan; no drain plug is provided. Clean the oil strainer before refilling.

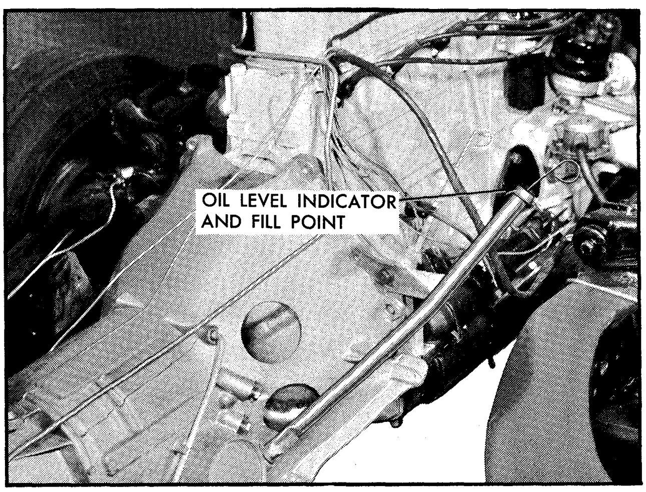



Fig. 7B-27 Location of Oil Level Indicator

To refill the transmission, replace the oil pan, using a new gasket, and add 5 pints of transmission fluid using filler tube and funnel. Start engine and allow engine to idle in Park (P) position 3-5 minutes to warm oil, then check oil and add as required to raise to the level of the FULL mark. Assuming that the converter was not drained (since it is welded) and allowing for a nominal spillage or drain-down, approximately 6 pints of oil will be required for refill.

*CAUTION: Do not overfill!*

The dry capacity of the V-8 or L-6 transmission, including converter, is approximately 19-1/2 pints. Normal refills require 6 pints.

### NEUTRALIZER AND BACK-UP LIGHT SWITCH

The starter neutralizer and back-up light switch is located on the gearshift control and indicator assembly.

Properly adjusted, the switch should turn on the back-up lights in reverse and prevent engine cranking with the selector lever in any position other than "N" (neutral or "P" (park). If the engine cranks in any other position, adjust the switch by loosening the two switch mounting screws and repositioning as required.

### SHIFT LINKAGE

If improper shaft linkage adjustment is suspected, adjustment can be made quickly as described below:

STANDARD

1. Loosen nut on swivel (Fig. 7B-28).

2. Set transmission selector lever in park position detent (clockwise to last detent).

3. Set shift lever in park position.

4. Tighten nut on swivel.

CONSOLE

1. Back off trunnion nuts on rod and trunnion assembly (Fig. 7B-29).

2. Set transmission selector lever in park position detent (clockwise to last detent).

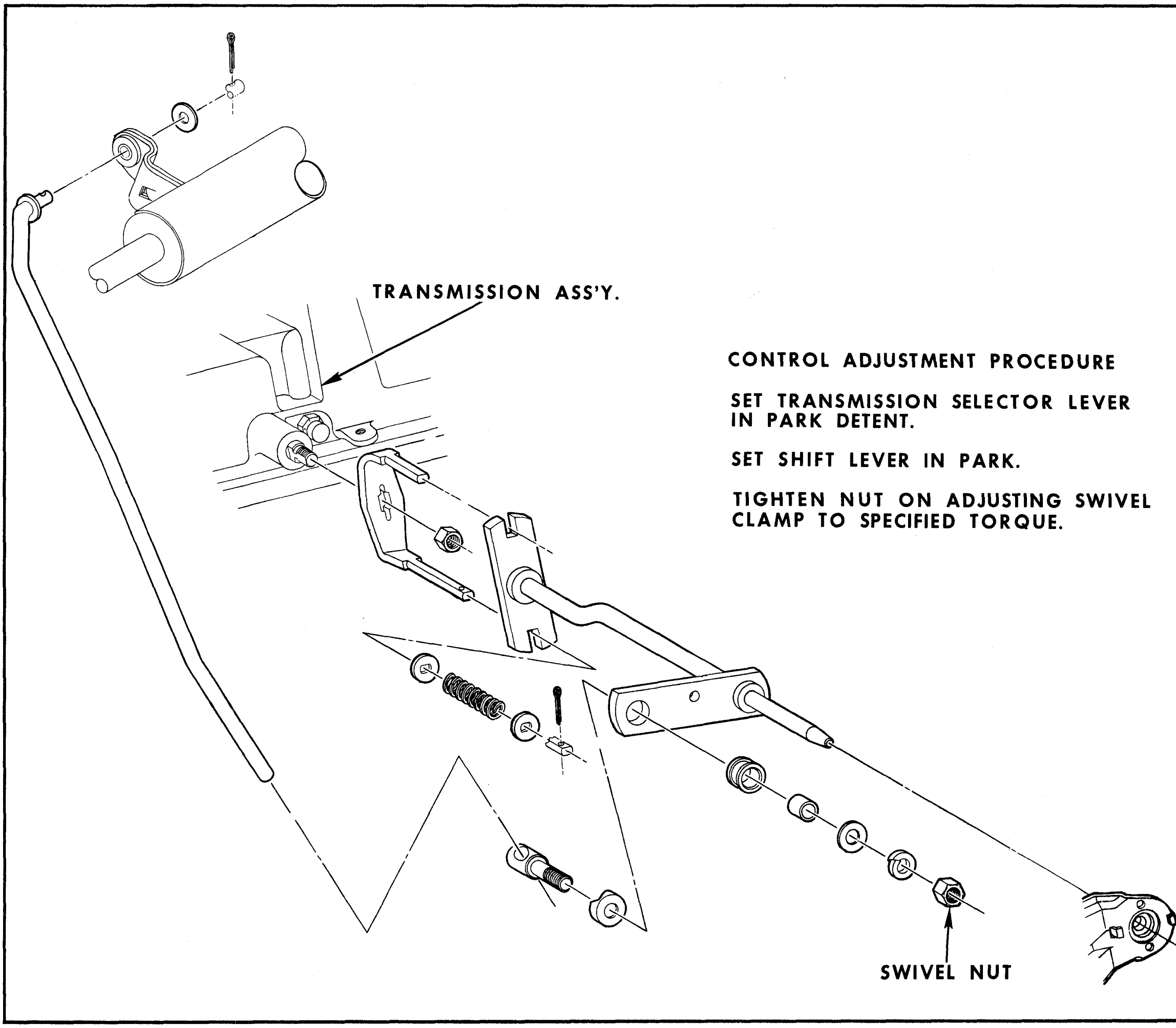



Fig. 7B-28 Standard Shift Control Linkage

3. Set shift lever in park position.

4. Tighten trunnion nuts.

### *LOW BAND*

Adjustment of the low band at 24,000 mile intervals is recommended. Adjustment is performed as follows:

Remove protective cap, loosen lock nut, and tighten adjusting screw to 40 ± 5 lb. in. torque; then back off four (4) full turns exactly. While holding adjusting screw stationary, tighten adjusting screw lock nut securely. Replace cap.

## SERVICE OPERATIONS— TRANSMISSION IN CAR

The Tempest automatic transmission service operations that can be performed while the transmission is in the car are covered below.

### *SHIFT LINKAGE (Fig. 7B-28 and 7B-29)*

If any components are worn or damaged so that replacement is necessary, refer to the Master Parts Catalog to determine which items are serviced separately and which are serviced in assembly.

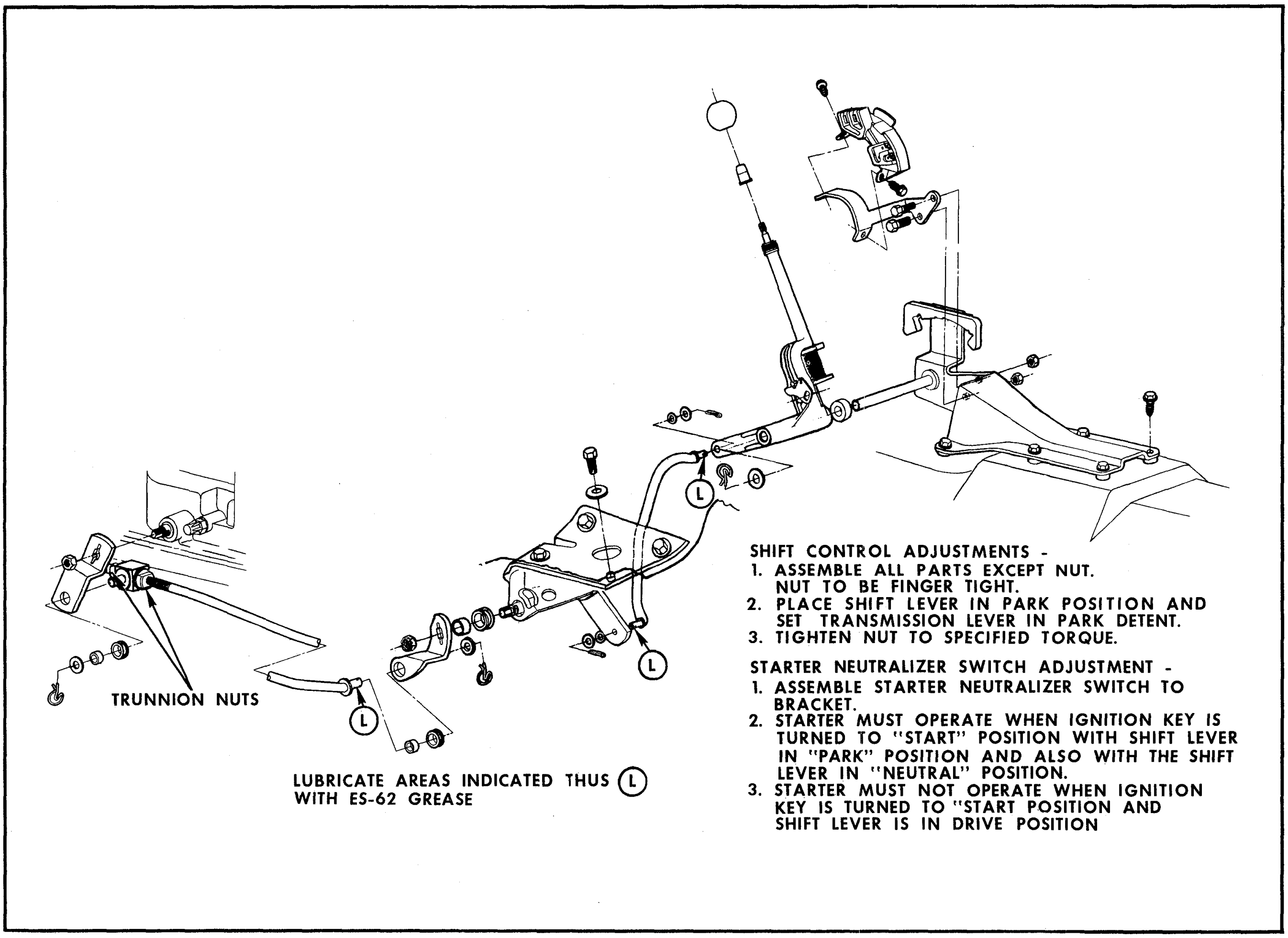



Fig. 7B-29 Console Shift Control Linkage

### *REAR BEARING RETAINER OIL SEAL OR BUSHING REPLACEMENT*

OIL SEAL

1. Remove propeller shaft (see Section 4).

2. Pry out old seal (Fig. 7B-30).

3. Coat outer casing of new oil seal with gasket sealing compound and drive it into place with installer J-5154 (Fig. 7B-31).

4. Install propeller shaft (see Section 4).

BUSHING

1. Remove propeller shaft (see Section 4).

2. Support transmission and remove frame cross member and rear engine mount.

3. Remove speedometer cable and speedometer driven gear assembly.

4. Remove rear bearing retainer.

5. Pry out old oil seal.

6. Remove old case to rear bearing retainer oil seal.

7. Remove old rear bearing retainer bushing using bushing chisel J-8400-1 (Fig. 7B-32).

8. Install new bushing from rear using installer J-21424-1 and handle J-8092 (Fig. 7B-33).

9. Coat outer casing of new oil seal with gasket sealing compound and drive it into place with installer J-5154 (Fig. 7B-31).

10. Install new case to rear bearing retainer oil seal.

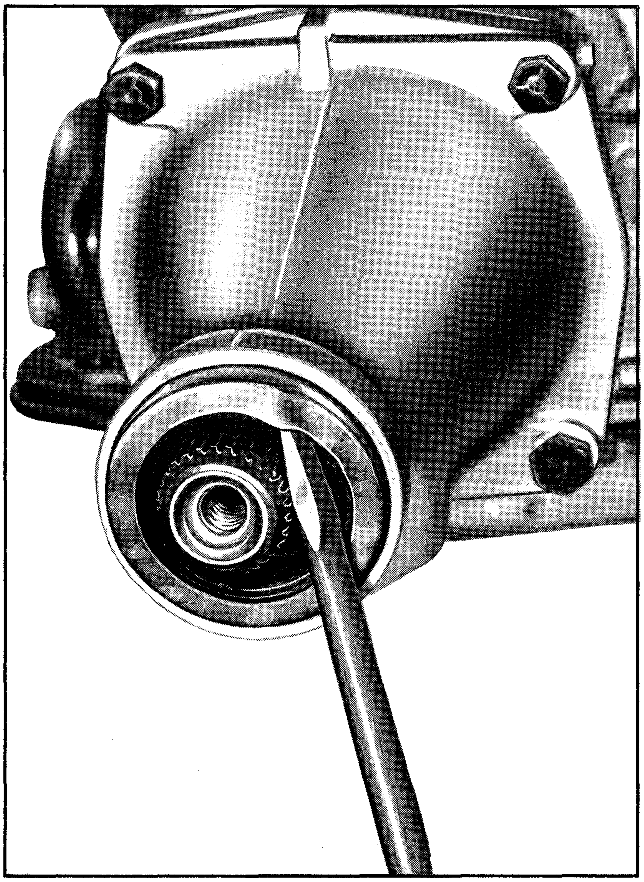


Fig. 7B-30 Removing Rear Bearing Retainer Oil Seal

11. Install rear bearing retainer. Tighten bolts to 25-35 lb. ft. torque.

12. Install frame cross member and rear mount.

13. Install propeller shaft (see Section 4).

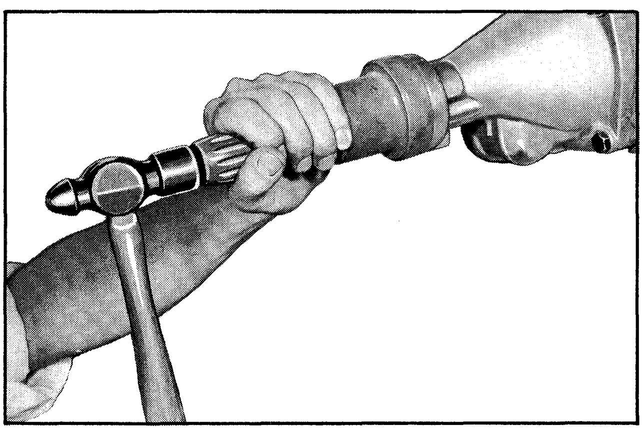


Fig. 7B-31 Installing Rear Bearing Retainer Oil Seal

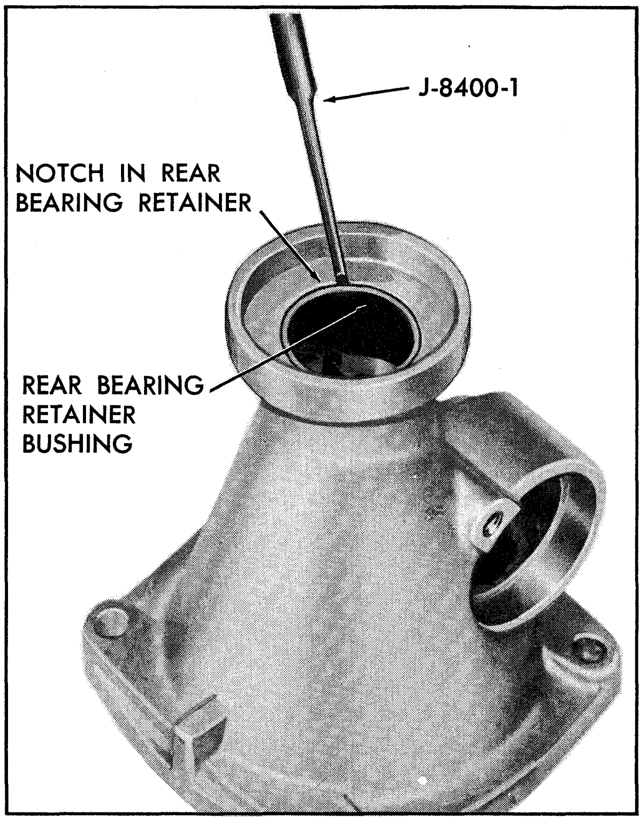



Fig. 7B-32 Removing Rear Bearing Retainer Bushing

14. Install speedometer driven gear assembly and connect cable.

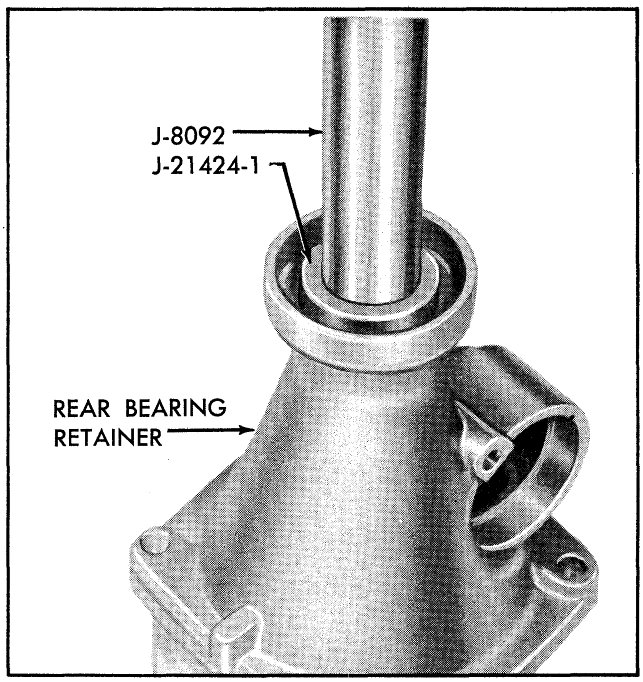



Fig. 7B-33 Installing Rear Bearing Retainer Bushing

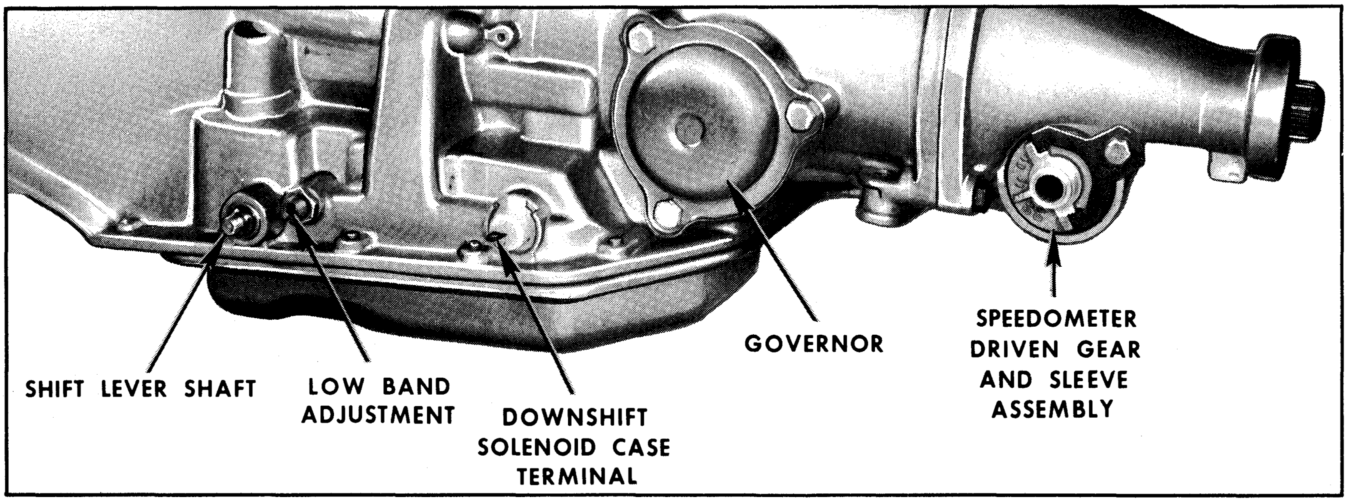



Fig. 7B-34 Transmission Assembly - Left Side View

***GOVERNOR (Fig. 7B-34)***

REMOVAL

1. Remove three bolts retaining governor cover to case. Remove cover and gasket.

2. Pull governor assembly out of case bore, allowing assembly to twist as driven gear disengages from drive gear teeth machined into output shaft (Fig. 7B-35).

INSPECTION

Check for sticking governor valve, broken or missing governor weight springs, damaged driven gear or worn weight pins. None of the governor components are replaceable; replace as an assembly.

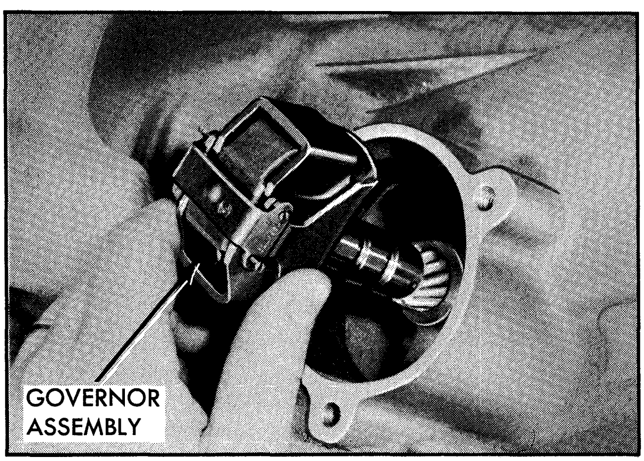



Fig. 7B-35 Removing Governor Assembly

INSTALLATION

1. Insert governor into case bore with a slight counterclockwise twist to engage gear teeth.

2. Using new gasket, install cover and retain with three bolts. Tighten bolts to 8-12 lb. ft. torque.

***VACUUM MODULATOR (Fig. 7B-36)***

Do not replace vacuum modulator before making the pressure check described in TROUBLE DIAGNOSIS at the end of Section 7B.

*NOTE: Vacuum modulator is not adjustable.*

REMOVAL

1. Remove vacuum hose at vacuum modulator.

2. Remove vacuum modulator retainer bolt and retainer.

3. Pull vacuum modulator (Fig. 7A-37) and valve assembly (Fig. 7A-38) out of case bore.

*NOTE: To remove the front modulator valve it may be necessary to use a magnet or "retriever".*

INSPECTION AND REPAIRS

Check the modulator valve assembly for burrs. If such minor imperfections cannot be removed with a slip stone, replace the valves.

The modulator diaphragm can be checked with a vacuum source for leakage. However, diaphragm leakage normally permits transmission oil pull-over, which is evident as smoky exhaust and continually

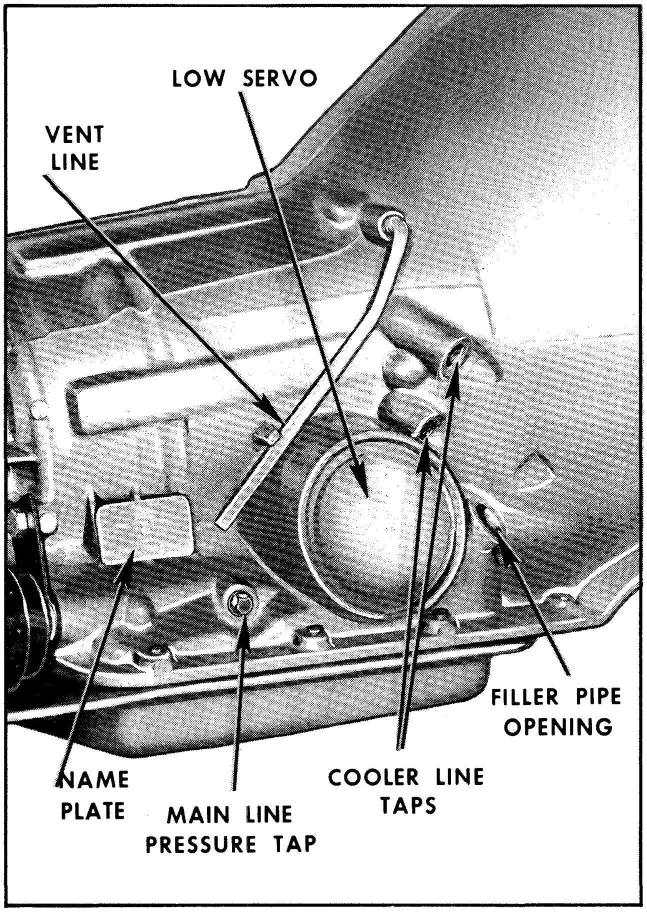



Fig. 7B-36 Transmission Assembly - Right Side View

low transmission oil level. No modulator repairs are possible; replace as an assembly.

Inspect case to vacuum modulator oil seal. Discard seal if it is nicked, cut or deteriorated.

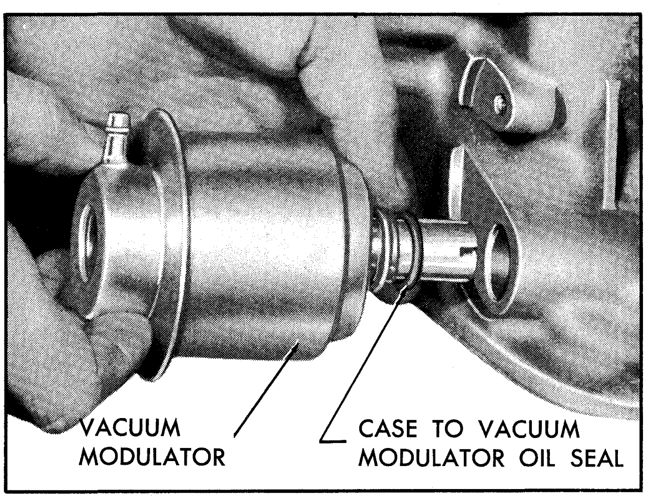



Fig. 7B-37 Removing Vacuum Modulator

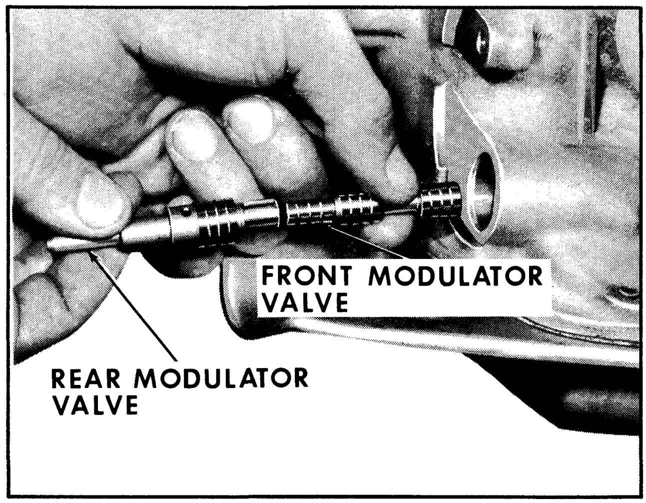



Fig. 7B-38 Removing Vacuum Modulator Valve Assembly

INSTALLATION

1. Install modulator valve assembly into case bore. (Refer to Fig. 7B-38 for correct assembly sequence.)

2. Assemble oil seal on vacuum modulator and install assembly into case bore.

3. Secure modulator assembly with retainer and bolt and tighten bolt 8-12 lb. ft. torque. Connect vacuum hose.

***SPEEDOMETER DRIVEN GEAR AND SLEEVE***

REMOVAL

1. Disconnect speedometer cable.

2. Remove speedometer driven gear sleeve retainer bolt.

3. Remove retainer and speedometer driven gear assembly.

*NOTE: Transmissions in cars with trailer provisions use a different retainer and an adapter (Fig. 7B-39).*

INSPECTION AND REPAIRS (Fig. 7B-40)

Inspect both oil seals for nicks, cuts, or deterioration. Discard damaged seals. Check the driven gear for wear or damage; replace if necessary.

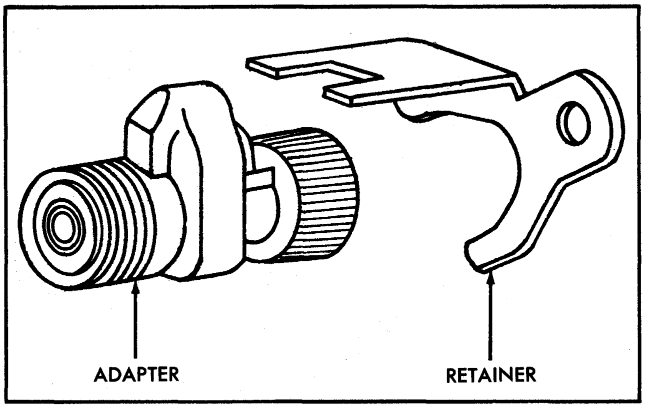



Fig. 7B-39 Speedometer Driven Gear Adapter and Retainer - Trailer Provision

INSTALLATION

1. Assemble speedometer gear and sleeve assembly (Fig. 7B-40). Driven gear shaft oil seal lip must face driven gear.

2. Install assembly into case bore and secure with retainer and bolt.

*NOTE: Assembly must be rotated to align with retainer.*

3. Connect speedometer cable.

### DOWNSHIFT SOLENOID REPLACEMENT

1. Remove oil pan, gasket and oil strainer.

2. Disconnect solenoid connector from terminal (Fig. 7B-41).

*NOTE: Raise retaining finger on top of case terminal to permit disengaging connector and disengage wire from retaining clip.*

3. Remove solenoid attaching bolts. Remove solenoid and gasket.

4. Install new gasket on solenoid so that gasket notch will face bottom of valve body.

5. Install solenoid on valve body and secure connector to case terminal. Make certain that case terminal retaining finger engages connector and wire is retained by clip.

6. Install oil screen (make certain grommet is in good condition) and tighten retaining bolt to 8-11 lb. ft. torque. Install oil pan using a new gasket. Tighten oil pan bolts to 10-12 lb. ft. torque.

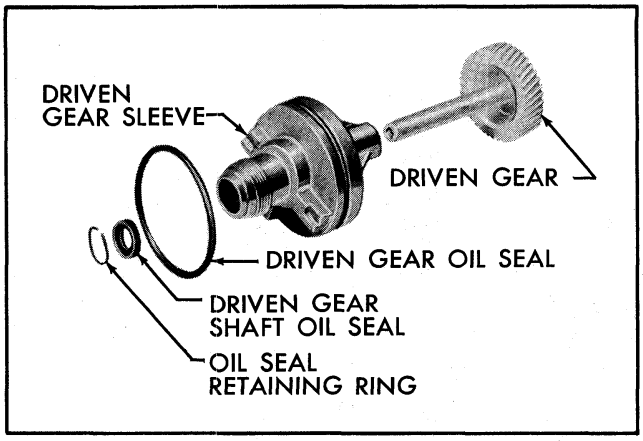



Fig. 7B-40 Speedometer Driven Gear and Sleeve Assembly - Exploded View

### VALVE BODY

REMOVAL

1. Remove oil pan and gasket.

2. Remove oil strainer retaining bolt and remove strainer (Fig. 7B-41) using a twisting motion. Remove oil strainer pipe from case, but only if necessary because seal failure is suspected.

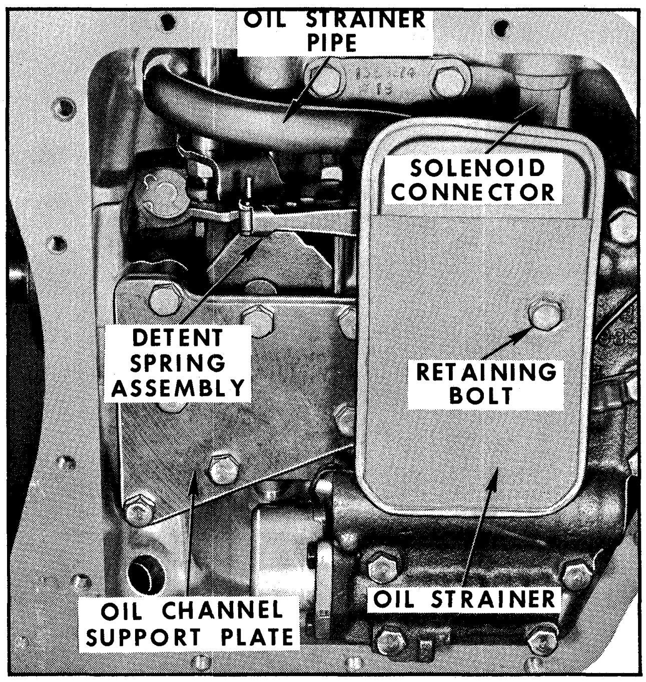



Fig. 7B-41 Transmission - Oil Pan Removed

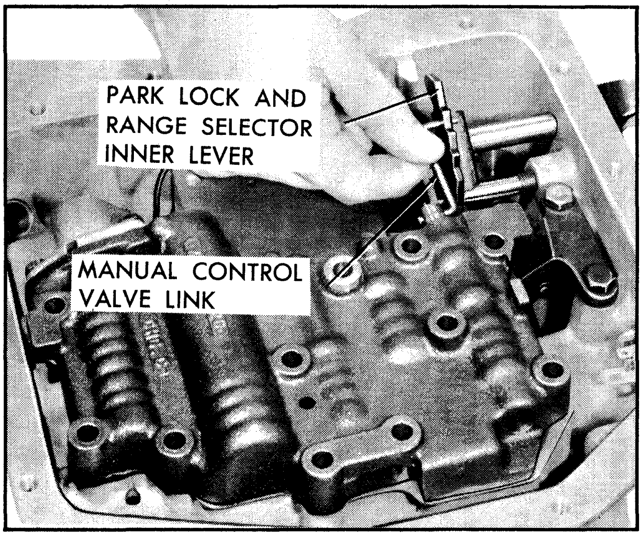



Fig. 7B-42 Disengaging Manual Control Valve Link

3. Disconnect solenoid connector from terminal (Fig. 7B-41).

*NOTE: Raise retaining finger on top of case terminal to permit disengaging connectors.*

4. Remove detent spring assembly from valve body (Fig. 7B-41).

5. Remove remaining valve body bolts and hold valve body in position.

6. Disengage manual control valve link from park lock and range selector inner lever by rotating valve body (Fig. 7B-42).

7. Remove valve body. Remove manual control valve and link from valve body.

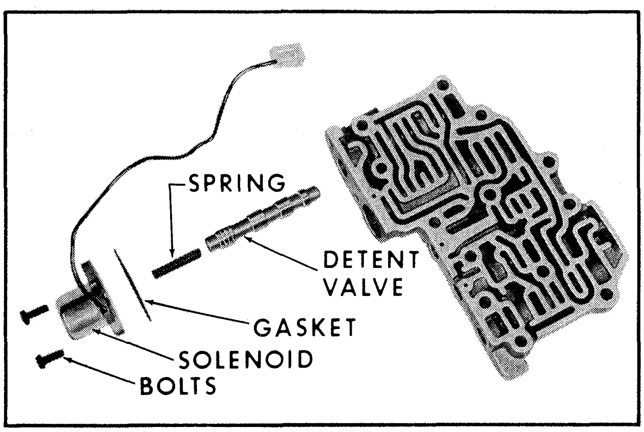



Fig. 7B-43 Downshift Solenoid and Detent Valve - Exploded View

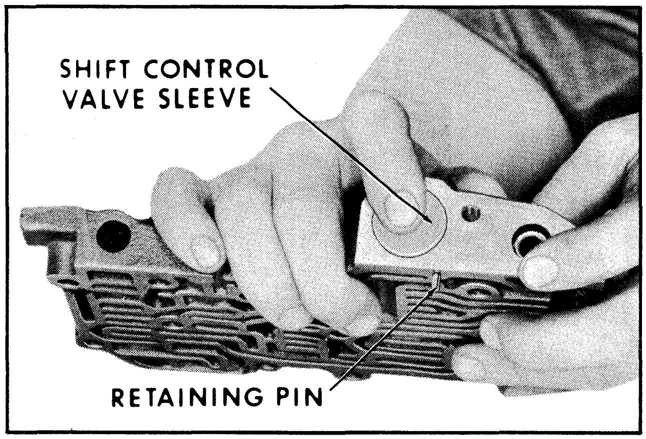



Fig. 7B-44 Removing Shift Control Valve Sleeve

8. If necessary, remove oil channel support plate (Fig. 7B-41), valve body plate, and plate to case gasket.

DISASSEMBLY

1. Remove downshift solenoid, gasket, spring, and detent valve (Fig. 7B-43).

2. Depress shift control valve sleeve and remove retaining pin by turning valve body over so pin can fall free (Fig. 7B-44). Remove shift control valve sleeve, shift control valve, spring, washer, and shift valve.

*NOTE: Modulator limit valve spring is under moderate pressure. Care should be exercised during removal during step 3 below.*

3. Depress modulator limit valve spring (using J-21361) and turn valve body over so that retaining pin falls free. Remove spring and valve (Fig. 7B-45). (Needle nose pliers can be used to depress spring and work out pin.)

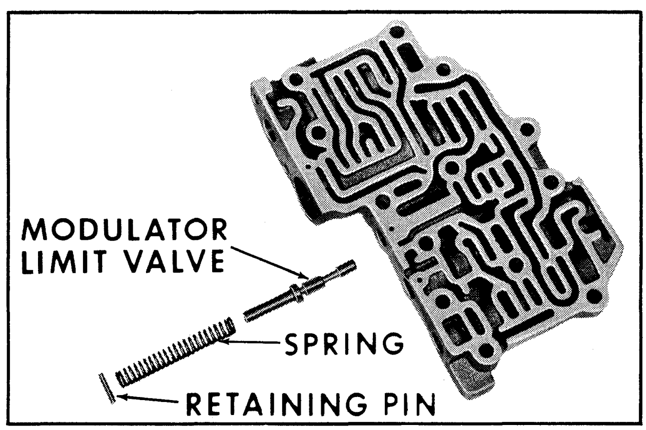



Fig. 7B-45 Modulator Limit Valve - Exploded View

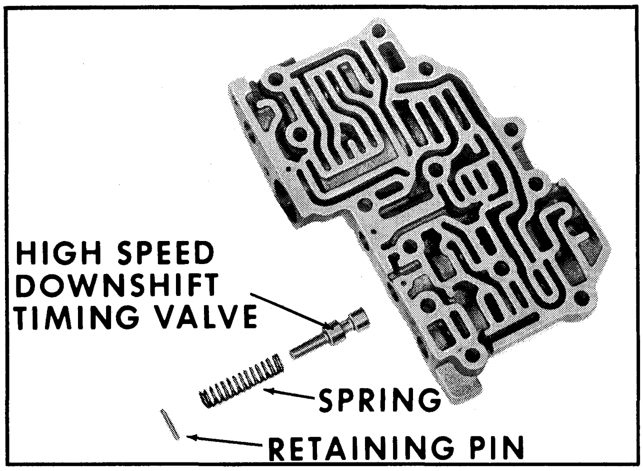



Fig. 7B-46 High Speed Downshift Timing Valve - Exploded View

4. Depress high speed downshift timing valve spring (using J-21361) and remove retaining pin by turning valve body over so that pin can fall free. Remove spring and valve (Fig. 7B-46). (Needle nose pliers can be used to depress spring and work out pin.)

INSPECTION

As most valve body failures are initially caused by dirt or other foreign material preventing a valve from functioning properly, a thorough cleaning of all parts in clean solvent is mandatory. Check all valves and their operating bores for burrs or other deformities that could cause valve "hang-up". Discard oil strainer grommet.

ASSEMBLY

1. Install high speed downshift timing valve and spring (Fig. 7B-46). Depress spring with needle nose pliers and install retaining pin.

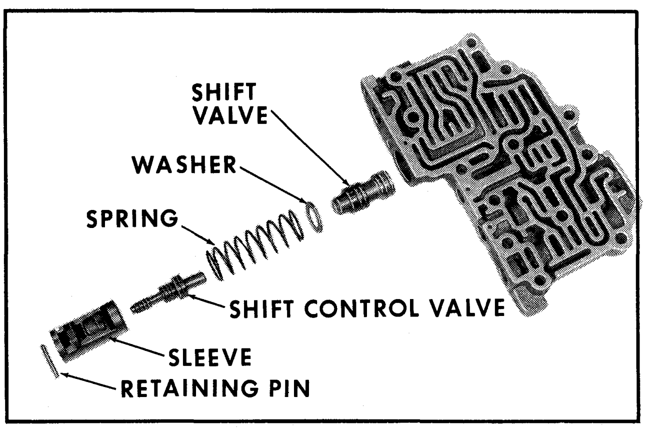



Fig. 7B-47 Shift Valve and Shift Control Valve

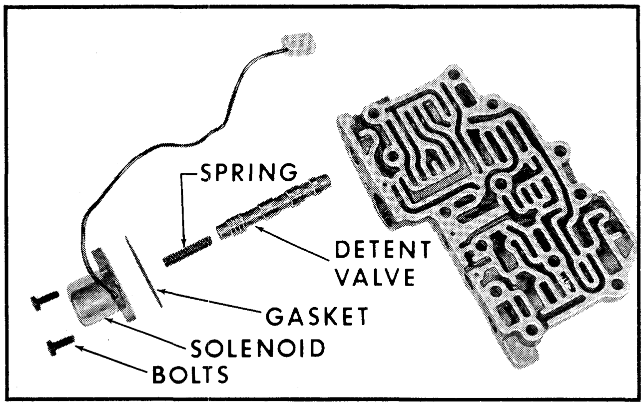



Fig. 7B-48 Downshift Solenoid and Detent Valve - Exploded View

2. Install modulator limit valve and spring (Fig. 7B-45). Depress spring with needle nose pliers and install retaining pin.

3. Install shift valve, washer, spring, shift control valve, and shift control valve sleeve (Fig. 7B-47). Depress shift control valve sleeve and install retaining pin.

4. Install detent valve and spring (Fig. 7B-48). Install gasket on downshift solenoid with notch facing bottom of valve body and install downshift solenoid. Tighten bolts to 8-12 lb. ft. torque.

INSTALLATION

1. If previously removed, install new valve body plate to case gasket, using petrolatum to hold it in position. Install valve body plate and oil channel support plate. Install bolts finger tight.

2. Install manual control valve and link into valve body.

3. Engage manual control valve link in park lock and range selector inner lever (Fig. 7B-49).

4. Install spring detent assembly on valve body (Fig. 7B-50). (Note routing of solenoid wire and wire retaining clip position.)

5. Install remaining valve body to case bolts (except oil strainer retaining bolt) and tighten all bolts to 8-11 lb. ft. torque.

6. Connect solenoid connector to case terminal (Fig. 7B-50). Make certain that case terminal retaining finger engages connector and wire is retained by clip.

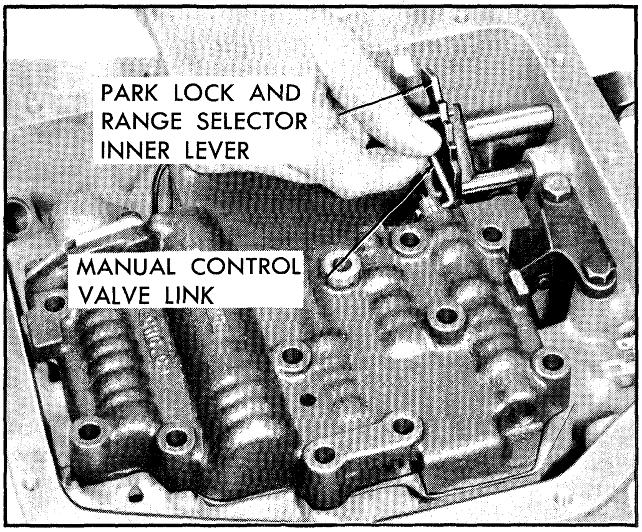



Fig. 7B-49 Engaging Manual Control Valve Link

7. If previously removed, install oil strainer pipe to case seal on oil strainer pipe. Lubricate seal and install pipe into case.

8. Install oil strainer to oil strainer pipe grommet. Lubricate grommet and install strainer on pipe with a twisting motion. Install and tighten oil strainer bolt to 8-11 lb. ft. torque.

9. Install oil pan, using a new gasket. Tighten oil pan bolts to 10-12 lb. ft. torque.

***PRESSURE REGULATOR***

REMOVAL

1. Remove oil pan and gasket.

*CAUTION: Valve spring is under high pressure. Use extreme care after snap ring has been removed in step 2 below.*

2. Compress main pressure regulator valve spring by pressing on boost valve sleeve and remove snap ring (Fig. 7B-51).

3. Remove boost valve sleeve, valve, spring, washer and pressure regulator valve.

INSPECTION

Inspect pressure regulator valve, boost valve, and boost valve sleeve for nicks or burrs that could

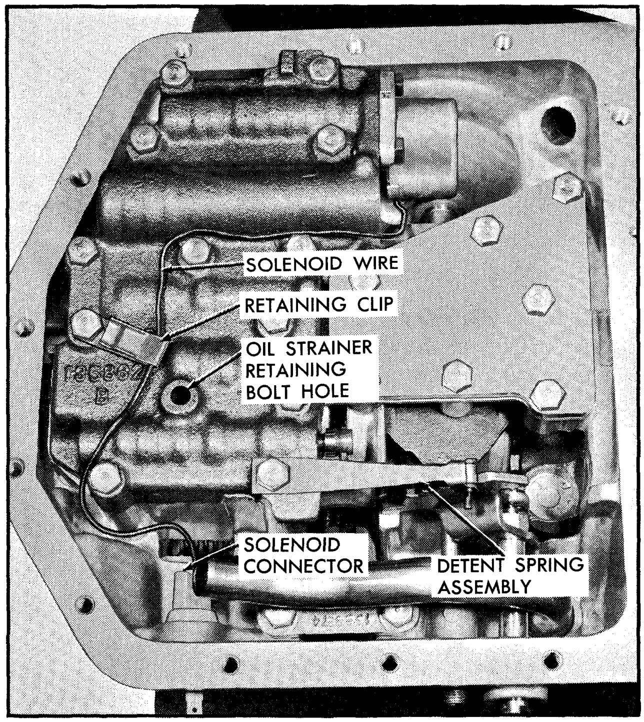



Fig. 7B-50 Transmission - Oil Pan and Strainer Removed

interfere with proper operations. If minor imperfections cannot be removed with a slip stone, replace parts as required.

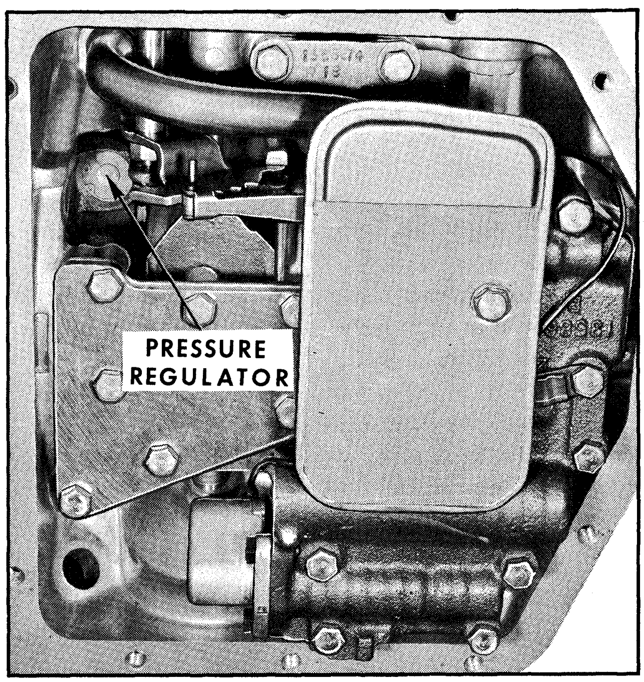



Fig. 7B-51 Pressure Regulator Location

ASSEMBLY

1. Refer to Fig. 7B-103 for correct assembly sequence.

2. Install pressure regulator valve, washer, spring and boost valve and sleeve into pump body.

*NOTE: Later production transmissions incorporate a C type spring washer and may have one or two C type spacers behind the washer. Install the same number of spacers originally removed.*

3. Compress valve spring by depressing boost valve sleeve and install snap ring.

4. Install new gasket and install oil pan.

## TRANSMISSION REMOVAL AND INSTALLATION

1. Disconnect speedometer cable and remove speedometer driven gear assembly to allow oil to drain during removal procedure.

2. Remove propeller shaft (see Section 4).

3. Disconnect vacuum line and downshift switch lead.

4. Disconnect shift control linkage from outer shift lever.

5. Support transmission and remove frame cross member.

6. Remove flywheel housing bottom cover.

7. Remove flywheel to converter mounting bolts. After bolts are removed, make certain converter hub is free of crankshaft.

8. Lower transmission and engine assembly to gain access to cooler line fittings (V-8 only). Disconnect cooler lines using a crow foot adapter and a suitable extension or using oil cooler pipe wrench J-21477.

*NOTE: On some cars it may be necessary to loosen exhaust system.*

9. With transmission in lowered position, remove case to engine bolts.

10. Move transmission down and to the rear and install converter holding strap J-21366 to hold converter in position until transmission is to be disassembled.

To install transmission, reverse the above procedure.

## TRANSMISSION DISASSEMBLY

Service procedures for the rear bearing retainer, governor, vacuum modulator, speedometer driven gear assembly, downshift solenoid, pressure regulator, and valve body are covered under SERVICE OPERATIONS - TRANSMISSION IN CAR, page 7B-21.

### *REMOVAL OF VALVE BODY, REAR BEARING RETAINER, SPEEDOMETER DRIVE GEAR, AND LOW SERVO*

1. Mount transmission in holding fixture J-8763 (Fig. 7B-52).

2. With transmission in horizontal position, pull out converter.

3. Remove valve body (see page 7B-26).

4. Remove speedometer driven gear assembly (see page 7B-25).

5. Remove governor assembly (see page 7B-24).

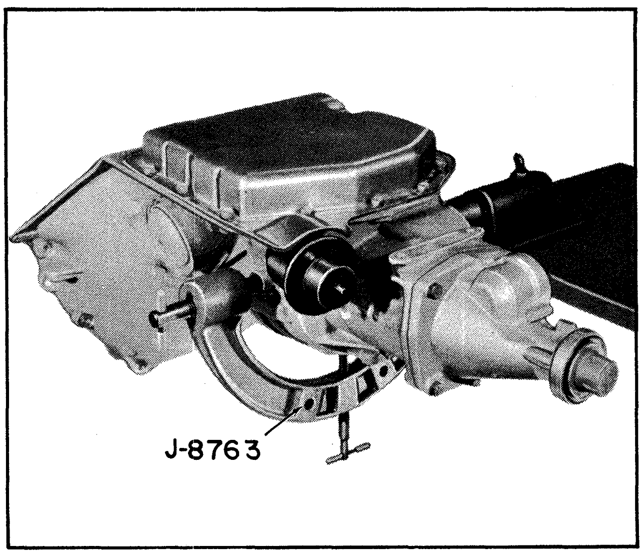



Fig. 7B-52 Transmission Mounted in Holding Fixture

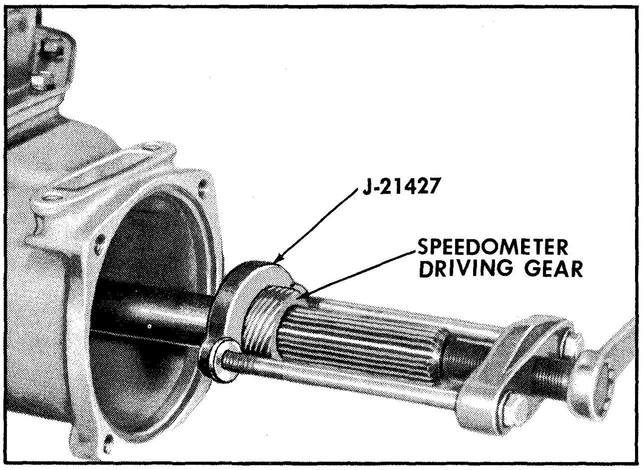



Fig. 7B-53 Removing Speedometer Drive Gear

6. Remove vacuum modulator (see page 7B-24).

7. Remove rear bearing retainer.

8. Place transmission in Park, then remove speedometer drive gear using J-21427 and J-8433 (Fig. 7B-53).

*NOTE: J-5814 may also be used with J-21427.*

## *REMOVAL OF OIL PUMP, FORWARD CLUTCH, AND LOW BAND*

*NOTE: Oil pump seal can be replaced without removing pump from case:*

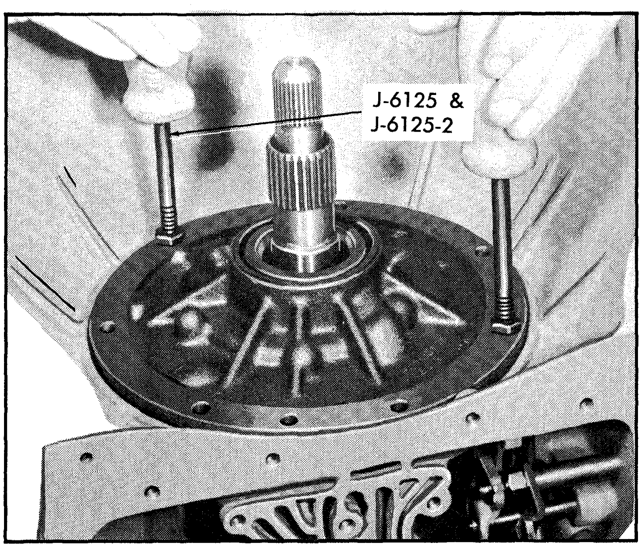



Fig. 7B-54 Removing Oil Pump

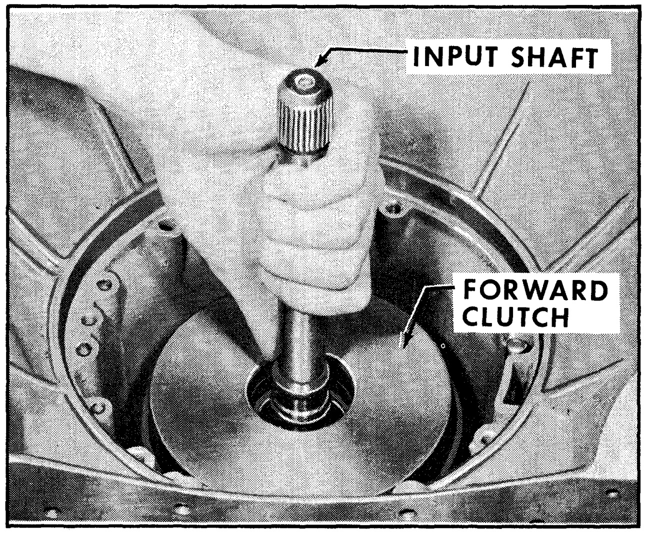



Fig. 7B-55 Removing Input Shaft

A. Pry out old seal.

B. Coat outer casing of new oil seal with gasket sealing compound and drive it into place with installer J-21359.

1. With transmission in vertical position, remove eight oil pump attaching bolts. Install slide hammers J-2619 into threaded holes in pump, loosen pump and remove pump and gasket (Fig. 7B-54).

2. Remove input shaft from forward clutch drum (Fig. 7B-55).

3. Remove forward clutch assembly by pulling straight out of case (Fig. 7B-56).

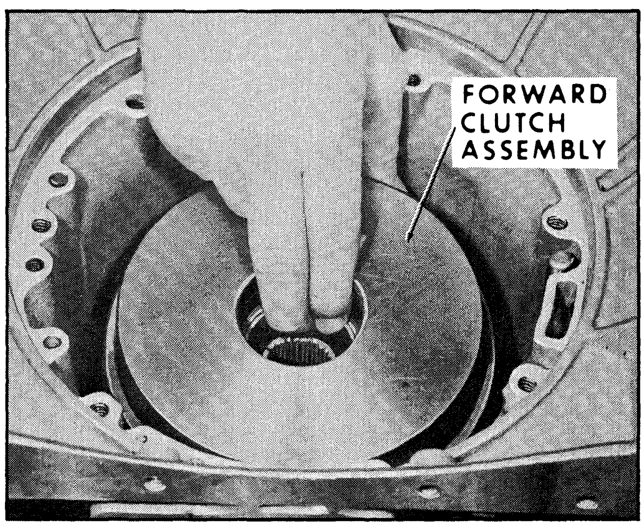



Fig. 7B-56 Removing Forward Clutch Assembly

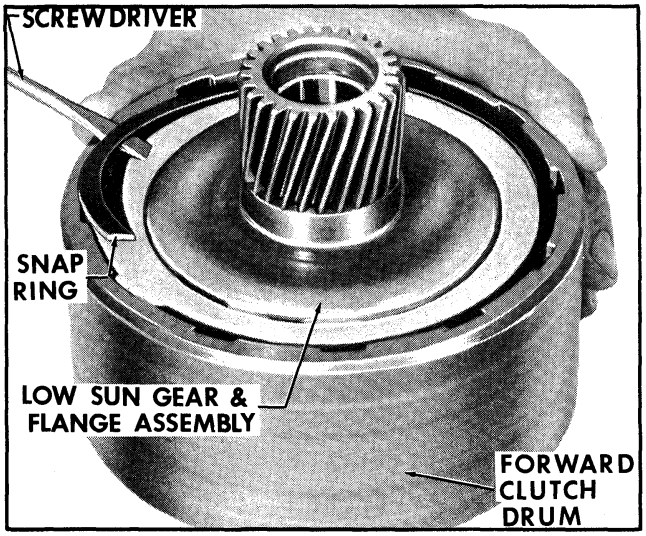



Fig. 7B-57 Removing Low Band and Struts

4. Remove low band and struts from case (Fig. 7B-57).

5. Remove low servo cover snap ring, using tool J-21495-1 to compress low servo cover so that snap ring can be removed (Fig. 7B-58).

6. Remove tool J-21495-1 from case and remove low servo cover. If necessary, tap lightly on low servo assembly piston rod to assist in removal of cover.

7. Remove low servo assembly from case.

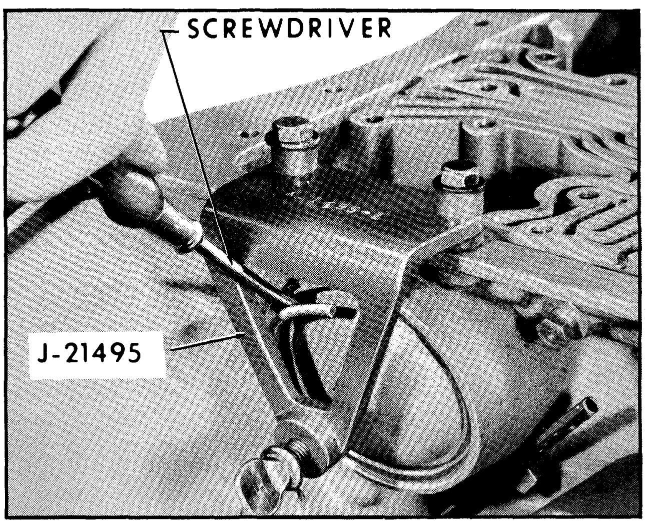



Fig. 7B-58 Removing Low Servo Cover Snap Ring

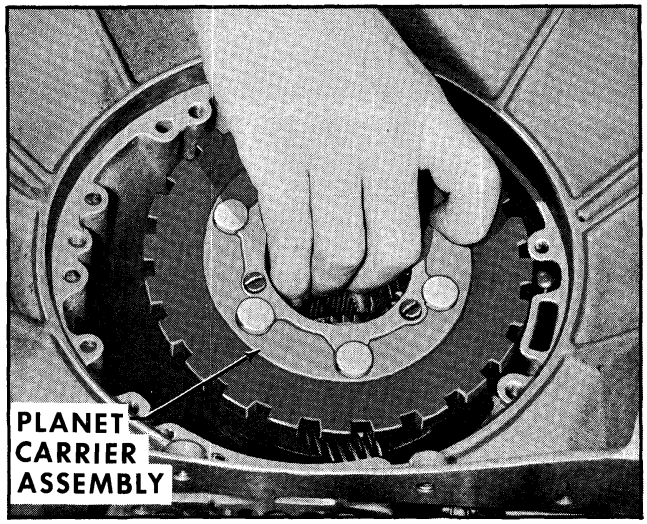



Fig. 7B-59 Removing Planet Carrier Assembly

***REMOVAL OF PLANETARY GEAR SET, REVERSE CLUTCH AND PISTON, AND PARK LOCK MECHANISM***

1. Pull planet carrier assembly from case, using care to avoid damaging case bushing (Fig. 7B-59) and remove reverse ring gear (Fig. 7B-60) thrust bearing and races (Fig. 7B-61).

2. With transmission in vertical position, remove reverse clutch pack snap ring with a screwdriver (Fig. 7B-62).

3. Lift reverse clutch pressure plate, clutch pack, and cushion spring from case.

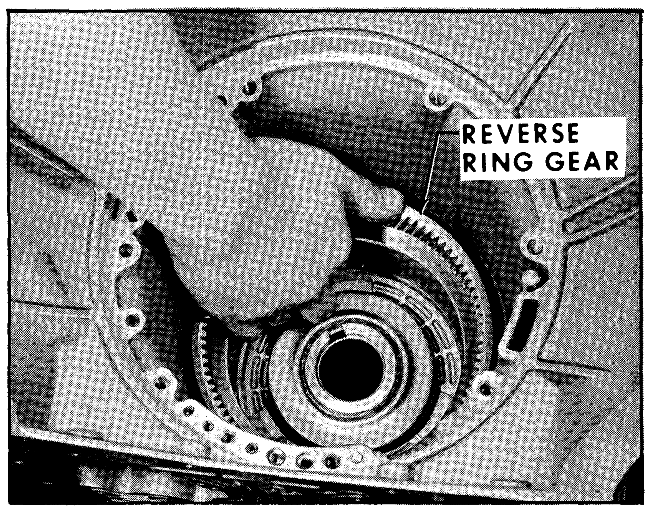



Fig. 7B-60 Removing Reverse Ring Gear

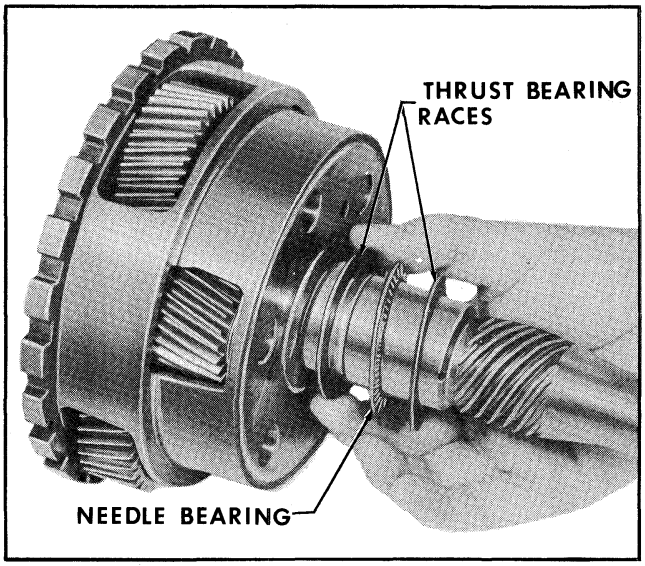



Fig. 7B-61 Removing Planet Carrier Thrust Bearing and Races

*NOTE: Position spring compressor so that reverse piston return seat snap ring gap is accessible in step 4 below.*

4. Compress reverse piston return springs using spring compressor J-9542 and adapters (Fig. 7B-63).

5. With return springs fully compressed, remove snap ring.

6. Release pressure on the return springs, being careful that piston return seat does not catch in snap ring groove. Remove return seat and springs.

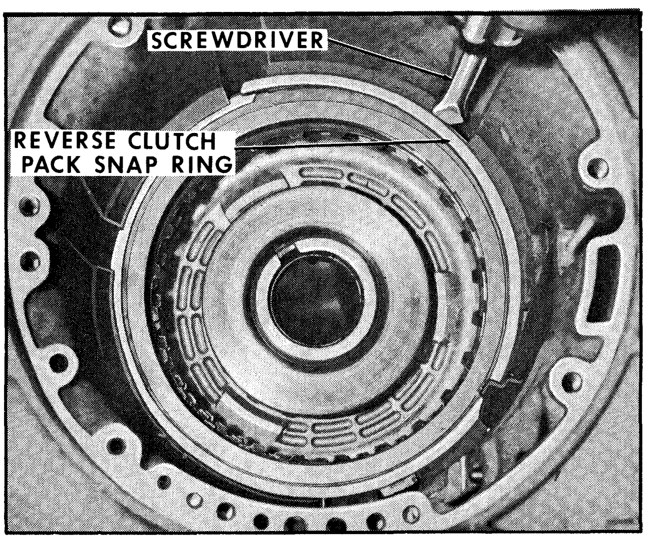



Fig. 7B-62 Removing Reverse Clutch Pack Snap Ring

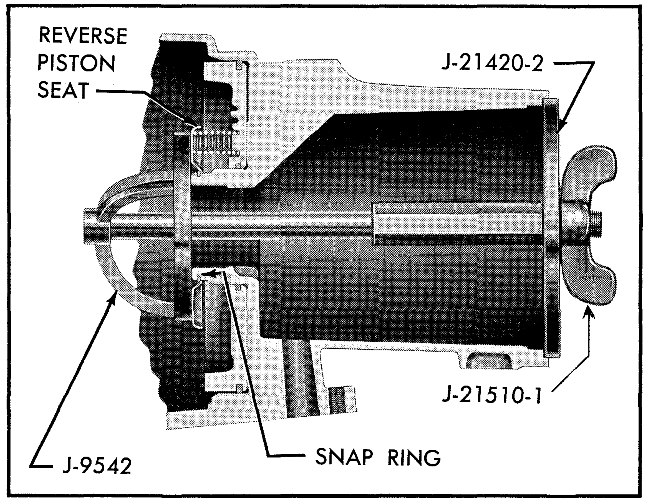



Fig. 7B-63 Compressing Reverse Piston Return Springs

7. With transmission in horizontal position, apply compressed air to reverse piston apply port to force out reverse piston (Fig. 7B-64).

8. Remove parking lock bracket (Fig. 7B-65).

9. Remove range selector shaft retainer (Fig. 7B-66).

10. Fully loosen nut that retains outer range selector lever shaft to inner park lock and range selector lever (Fig. 7B-67).

*NOTE: Before sliding range selector lever shaft out of case, remove any burrs on inner end of shaft that could score case bore or make removal difficult.*

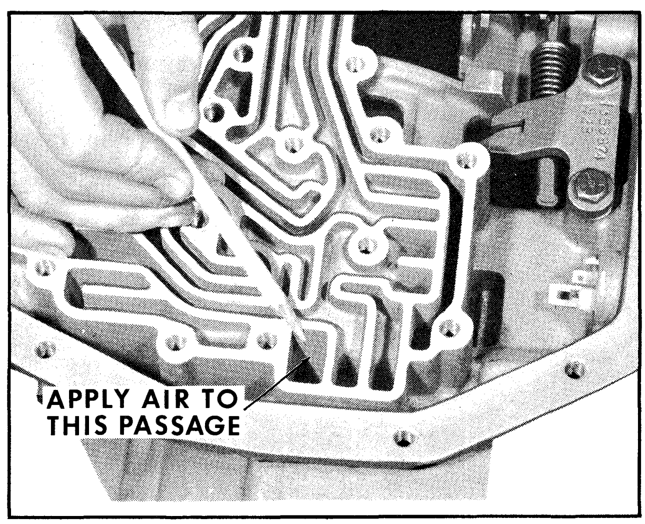



Fig. 7B-64 Reverse Piston Apply Passage

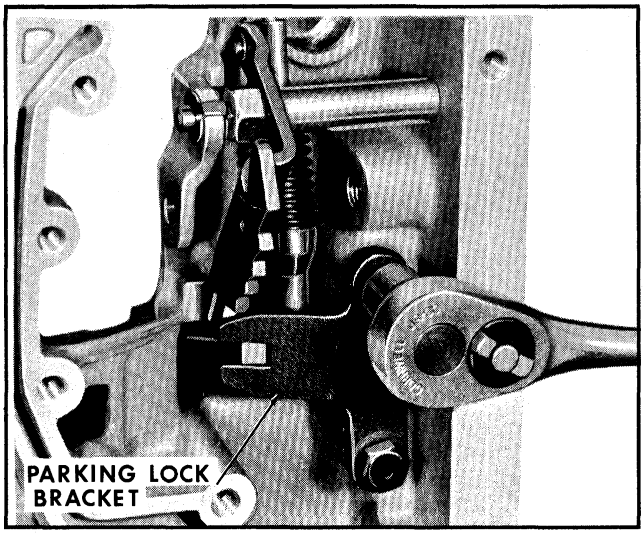



Fig. 7B-65 Removing Parking Lock Bracket

11. Slide range selector lever shaft out of case (see NOTE above). Remove nut and inner park lock and range selector lever.

12. Slide parking lock pawl shaft out of parking lock pawl (Fig. 7B-68). Remove parking lock pawl and spring.

## INSPECTION AND OVERHAUL OF INDIVIDUAL COMPONENTS

Service procedures for the rear bearing retainer, governor, vacuum modulator, speedometer driven gear assembly, downshift solenoid, valve body and pressure regulator are covered under SERVICE OPERATIONS - TRANSMISSION IN CAR, page 7B-21.

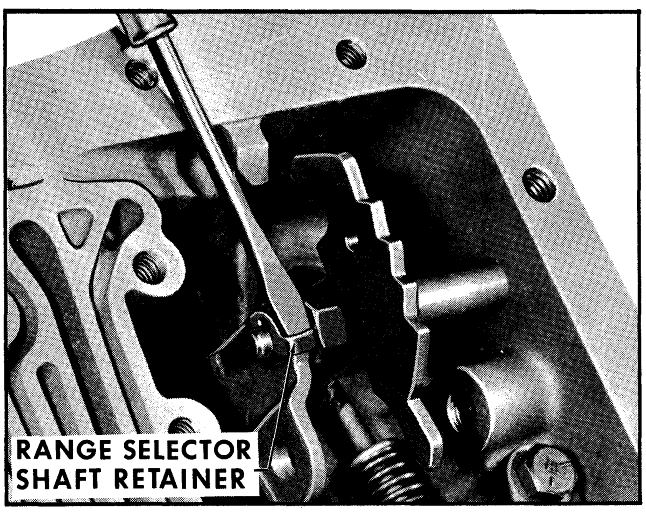



Fig. 7B-66 Removing Range Selector Shaft Retainer

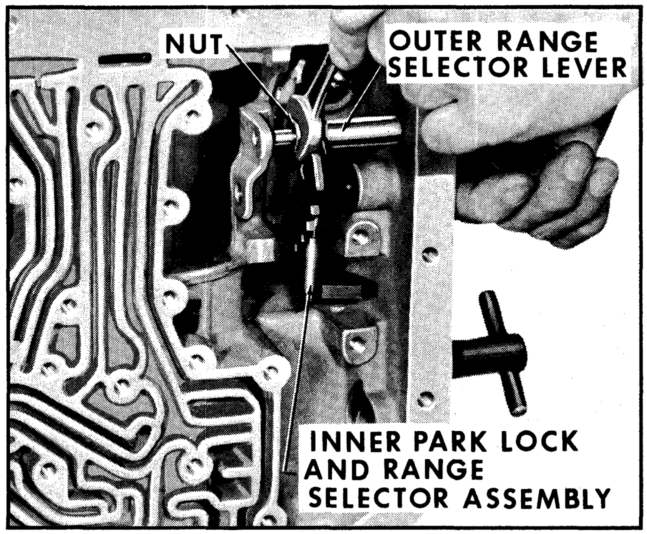



Fig. 7B-67 Removing Range Selector Shaft Nut

### *TRANSMISSION CASE*

INSPECTION

1. Inspect for hairline cracks or oil leaks.

2. Check for interconnected oil passages, using air gun or smoke.

3. Check bolt hole threads for cross threading or stripped condition.

4. Check case bushing for nicks, excessive scoring, or wear. If replacement is required, proceed as follows:

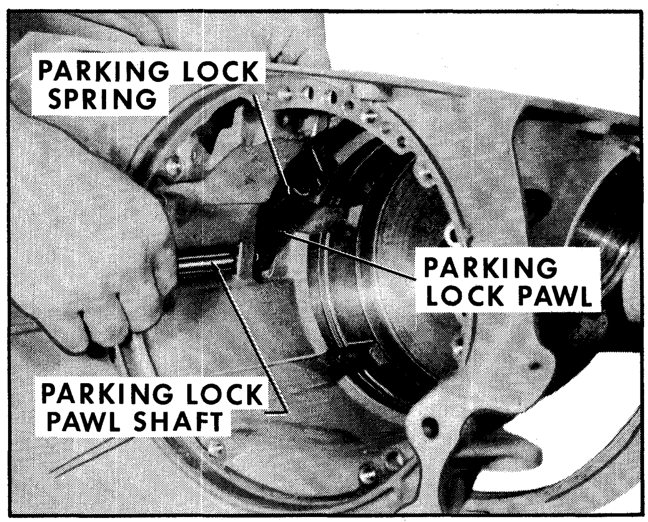



Fig. 7B-68 Removing Parking Lock Pawl Shaft

CASE BUSHING REPLACEMENT

1. Remove bushing using bushing chisel J-8400-1. Avoid damaging bushing bore.

2. Install new bushing using installer J-21424-2 and handle J-8092.

RANGE SELECTOR SHAFT OIL SEAL REPLACEMENT

1. Pry out old seal.

2. Tap new seal gently until it bottoms in case bore. Use a piece of flat metal or wood to avoid damaging seal.

## PARK LOCK ACTUATOR ASSEMBLY AND INNER PARK LOCK AND RANGE SELECTOR LEVER

DISASSEMBLY

Remove retainer ring that holds inner park lock and range selector to park lock actuator assembly (Fig. 7B-69).

INSPECTION

Check for worn or damaged parts and replace as required.

ASSEMBLY

Engage park lock actuator assembly in inner park lock and range selector lever and secure with retainer ring (Fig. 7B-69).

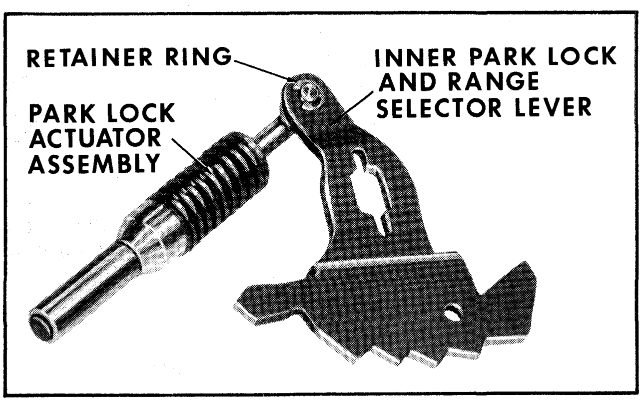



Fig. 7B-69 Park Lock Actuator and Range Selector Lever Assembly

## REVERSE CLUTCH AND PISTON

DISASSEMBLY AND INSPECTION

1. Remove and discard reverse piston inner and outer seals.

2. Check for broken piston return springs and make a comparative check of spring heights by standing all springs in a row. If there is appreciable difference in spring height, replace springs.

3. Examine clutch plates for evidence of wear or burning. Discard damaged plates.

4. Check piston for cracks or distortion.

ASSEMBLY

1. Check reverse piston thickness. L-6 piston is 1" thick; V-8 piston is 13/16" thick.

2. Lubricate with transmission oil and install inner and outer seals in reverse piston grooves.

## FORWARD CLUTCH

DISASSEMBLY

1. Remove low sun gear and flange assembly snap ring (Fig. 7B-70).

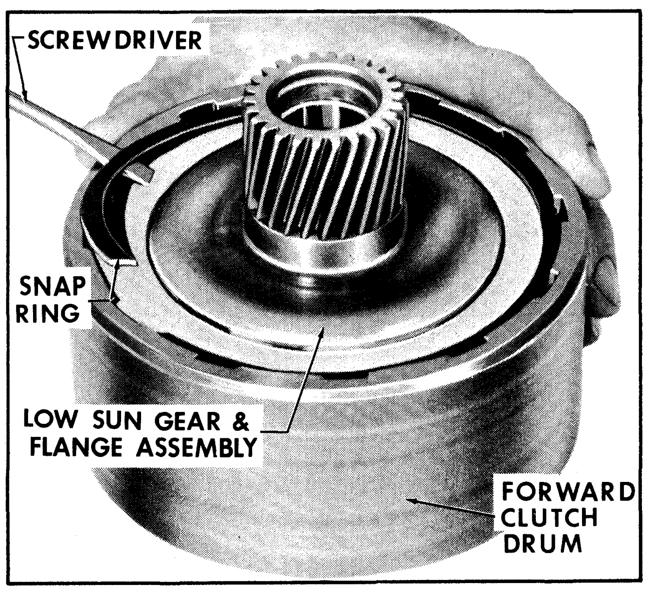



Fig. 7B-70 Removing Low Sun Gear and Flange Assembly Snap Ring

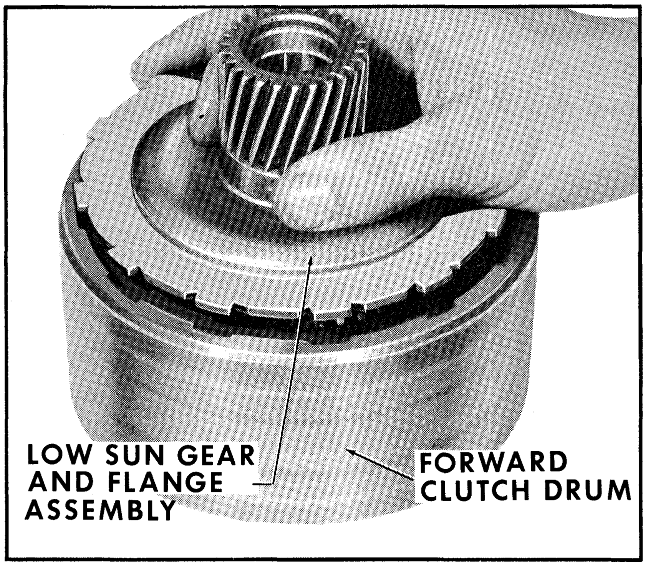



Fig. 7B-71 Removing Low Sun Gear and Flange Assembly

2. Remove low sun gear and flange assembly (Fig. 7B-71).

3. Remove clutch hub rear thrust washer (Fig. 7B-72).

4. Remove clutch hub (Fig. 7B-73).

5. Remove clutch hub front thrust washer (Fig. 7B-74).

6. Remove clutch pack.

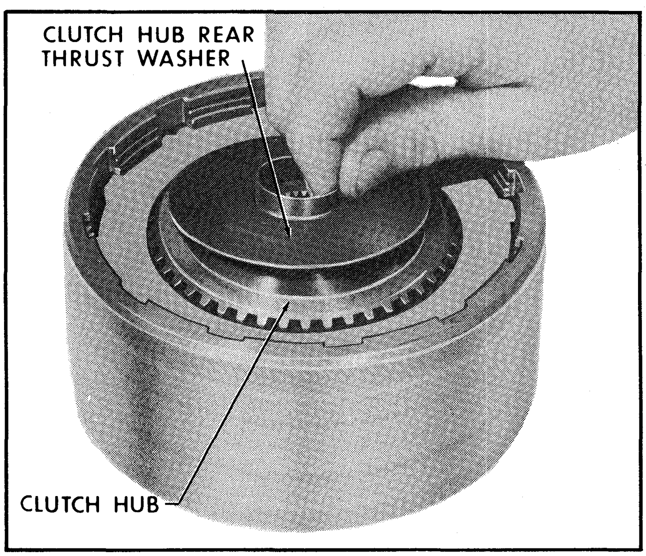



Fig. 7B-72 Removing Clutch Hub Rear Thrust Washer

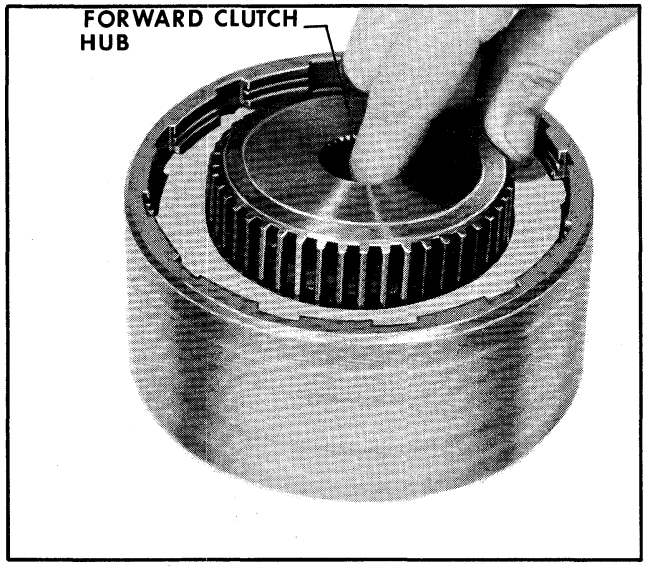



Fig. 7B-73 Removing Clutch Hub

7. Using spring compressor J-9542, compress piston return springs (Fig. 7B-75). Remove snap ring.

8. Carefully release pressure, then remove spring retainer and return springs.

9. Remove clutch piston with a twisting motion. Remove and discard outer seal on piston and inner seal on clutch drum hub.

INSPECTION

1. Wash all parts in cleaning solvent and air dry.


Fig. 7B-74 Removing Clutch Hub Front Thrust Washer

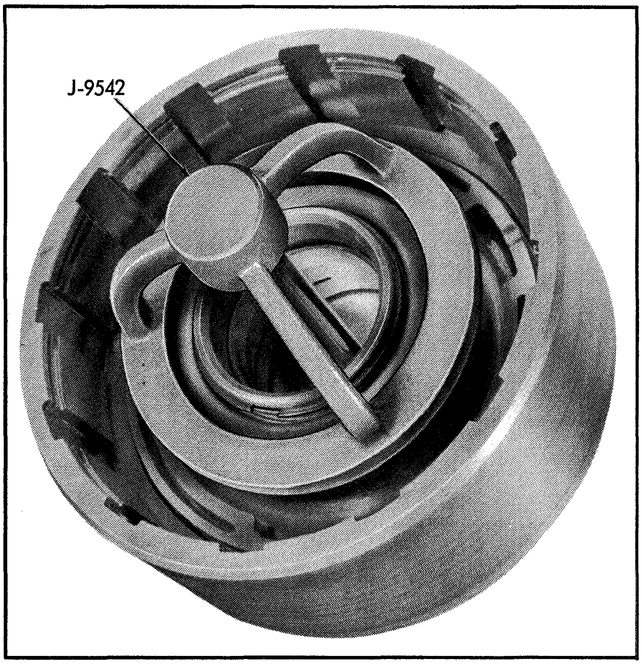



Fig. 7B-75 Compressing Forward Piston Return Springs

2. Inspect low band surface of clutch drum for excessive scoring or burning. Check clutch drum bushing for scoring or excessive wear. If bushing replacement is necessary, see Clutch Drum Bushing Replacement below.

3. Check steel ball in clutch drum that acts as a relief valve. Be sure that it is free to move and that the orifice in the front face of the drum is open. If the check ball is loose enough to come out or not loose enough to rattle, replace the clutch drum as an assembly. Replacement or restaking of the ball should not be attempted.

*NOTE: When the drum is rotating at high speed with enough fluid trapped in the piston apply area, centrifugal force acting on the fluid could partially apply the piston and burn the clutch pack unless the relief orifice is open. During normal piston application, oil pressure seats the ball and prevents loss of pressure.*

4. Check fit of low sun gear and flange assembly in drum slots. There should be no appreciable radial play. Inspect low sun gear for damage and bushing for wear.

5. Check clutch plates for burning, pitting, or metal pick up. Also check to see that faced plates are a free fit over clutch hub and that steel plates

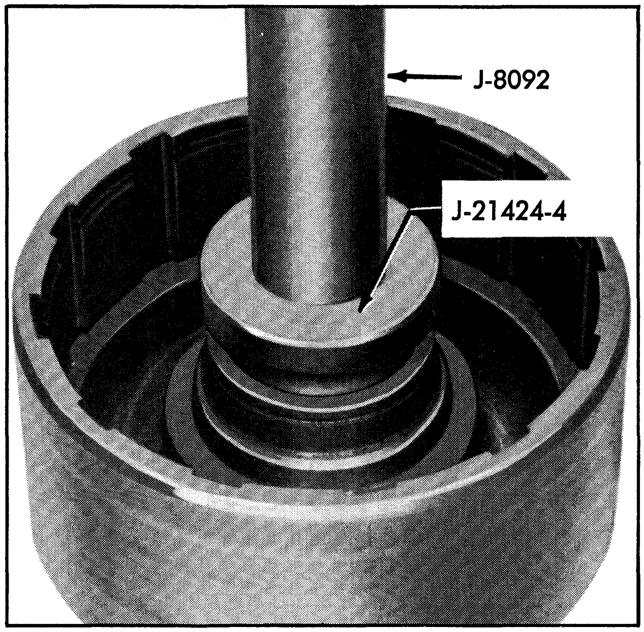



Fig. 7B-76 Removing Clutch Drum Bushing

are a free fit in clutch drum slots. Check for excessive wear on friction facing of drive plates. Examine condition of clutch hub splines and mating splines on faced plates.

6. Check piston for cracks or distortion.

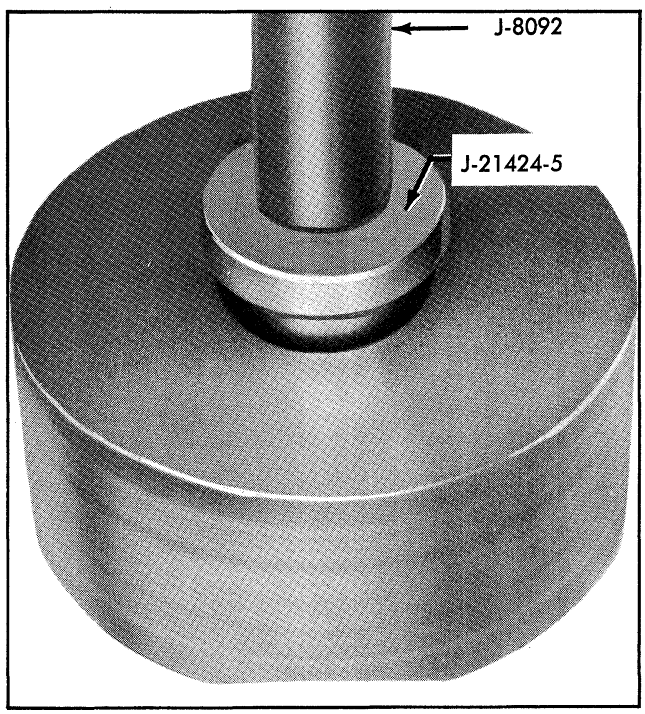



Fig. 7B-77 Installing Clutch Drum Bushing

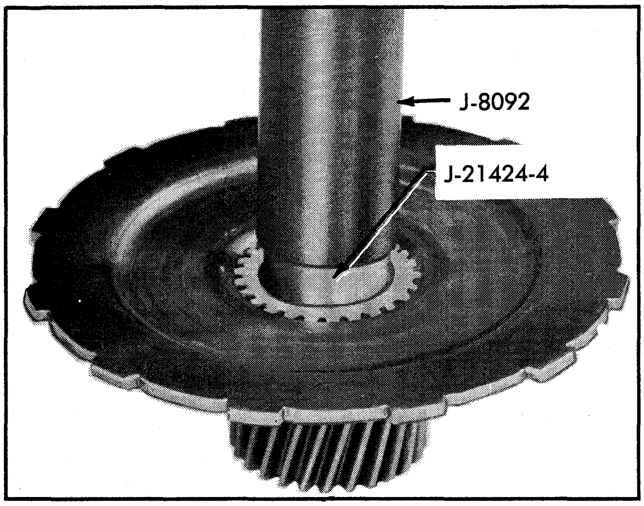



Fig. 7B-78 Removing Low Sun Gear Bushing

CLUTCH DRUM BUSHING REPLACEMENT

1. Remove old bushing using chisel J-8400-1 or tool J-21424-5 (Fig. 7B-76). Avoid damaging bushing bore.

2. Install new bushing using tool J-21424-5 (Fig. 7B-77). Press bushing in until tool touches front face of drum.

LOW SUN GEAR BUSHING REPLACEMENT

1. Remove old bushing using bushing chisel J-8400-1 or tool J-21424-4 (Fig. 7B-78). Avoid damaging bushing bore.

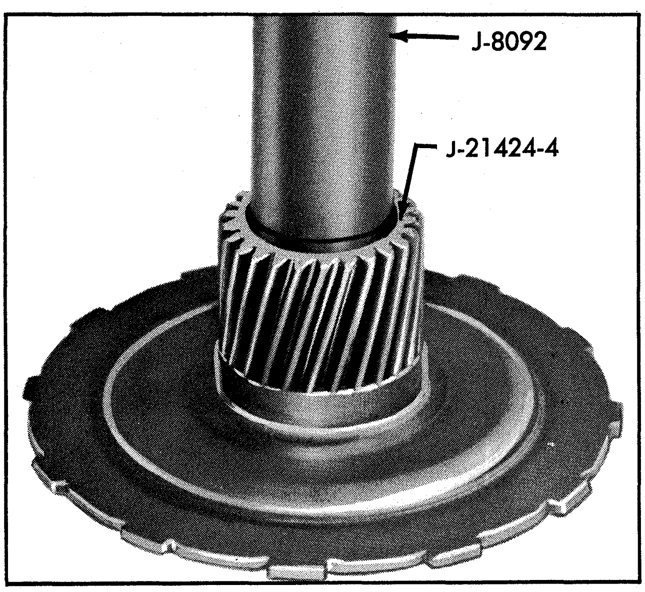



Fig. 7B-79 Installing Low Sun Gear Bushing

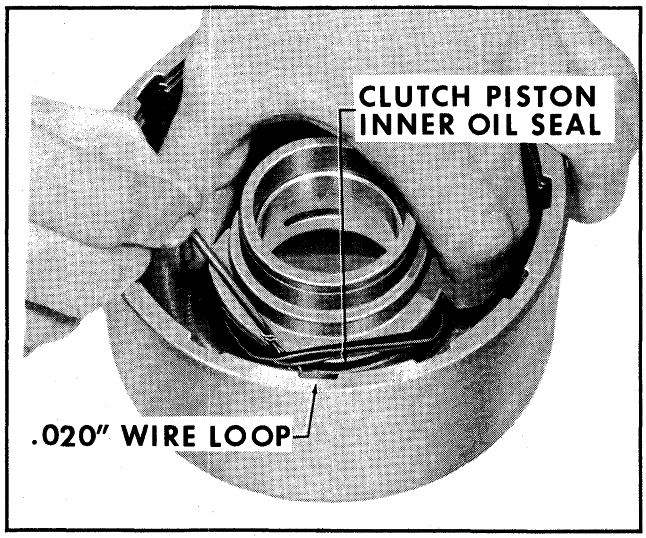



Fig. 7B-80 Installing Clutch Piston Inner Oil Seal

2. Install new bushing using tool J-21424-4 (Fig. 7B-79). Press in bushing until J-21424-4 is flush with face of sun gear.

ASSEMBLY

1. Lubricate a new piston inner seal with transmission oil and install in clutch hub groove with seal lip down (Fig. 7B-80). (A satisfactory tool for this operation can be made by crimping a loop of .020" music wire in a short length of copper tubing.)

*NOTE: Run fingers around seal after it is installed to verify that seal is fully in groove.*

2. Check forward clutch piston thickness. L-6 piston is 1-5/64" thick; V-8 piston is 29/32" thick.

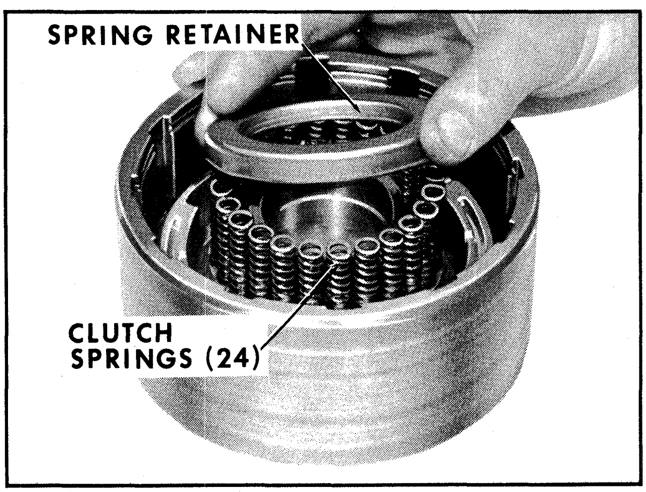



Fig. 7B-81 Installing Spring Retainer

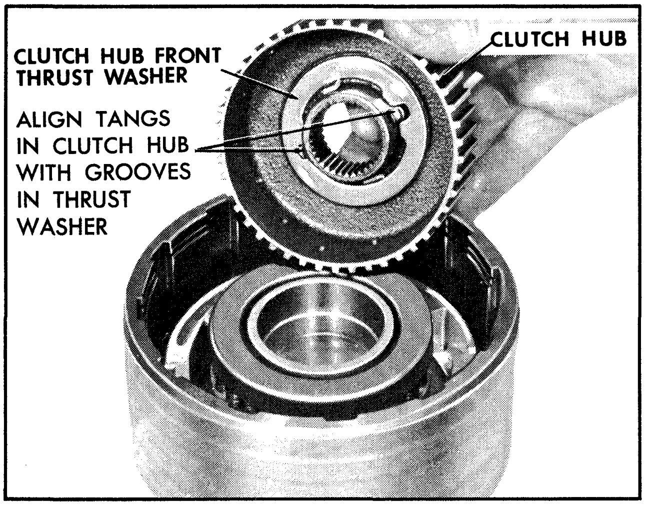



Fig. 7B-82 Installing Clutch Hub Front Thrust Washer

3. Lubricate a new piston outer seal with transmission oil and install in piston groove. Seal lip must face down.

4. Install forward clutch piston into clutch drum using a loop of smooth wire to start lip of seal into bore.

5. Install piston return springs and spring retainer (Fig. 7B-81). Place snap ring in position on top of retainer.

6. Compress return springs as shown in Fig. 7B-75 to expose snap ring groove. Install snap ring in clutch drum hub and remove compressor.

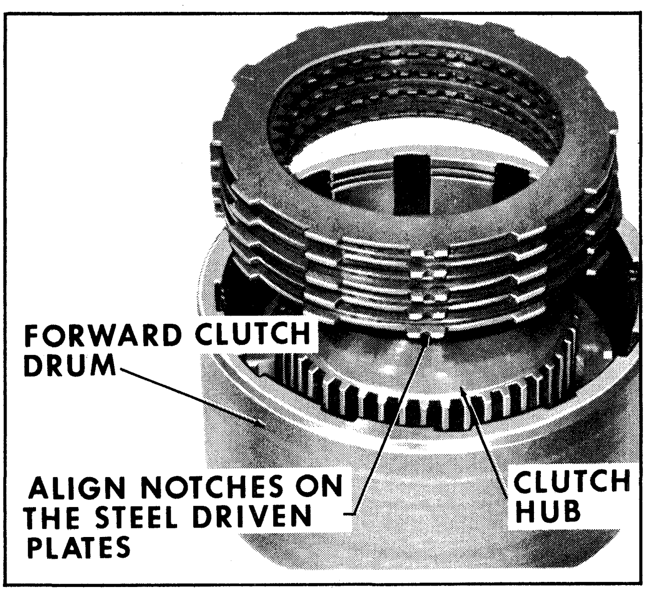



Fig. 7B-83 Installing Clutch Pack

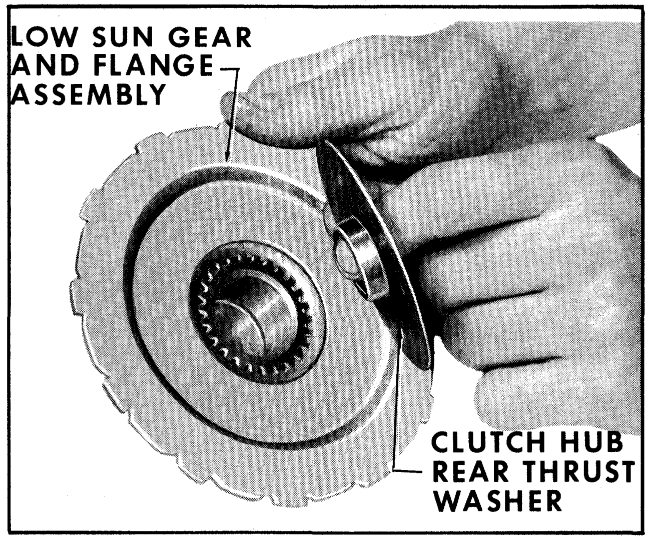



Fig. 7B-84 Installing Clutch Hub Rear Thrust Washer

7. Install clutch hub front thrust washer on clutch hub (retain with petrolatum) aligning tangs in clutch hub with grooves in thrust washer (Fig. 7B-82). Install clutch hub.

*NOTE: Notches on steel driven plates must be aligned in step 8 below.*

8. Install steel driven plates and faced drive plates alternately, beginning with a steel driven plate (Fig. 7B-83). (L-6 clutch pack contains 5 steel plates and 4 faced plates; V-8 clutch pack contains 6 steel plates and 5 faced plates.)

9. Install clutch hub rear thrust washer with flange in bore of low sun gear (Fig. 7B-84).

10. Install low sun gear and flange assembly and secure with snap ring. Position snap ring so that gap is centered between slots in drum.

### PLANET CARRIER

PRELIMINARY INSPECTION

1. Wash planet carrier assembly in cleaning solvent and air dry.

2. Inspect planet pinions for nicks or other tooth damage.

3. Check end clearance of planet pinions. This clearance should be .006"-.030" (Fig. 7B-85).

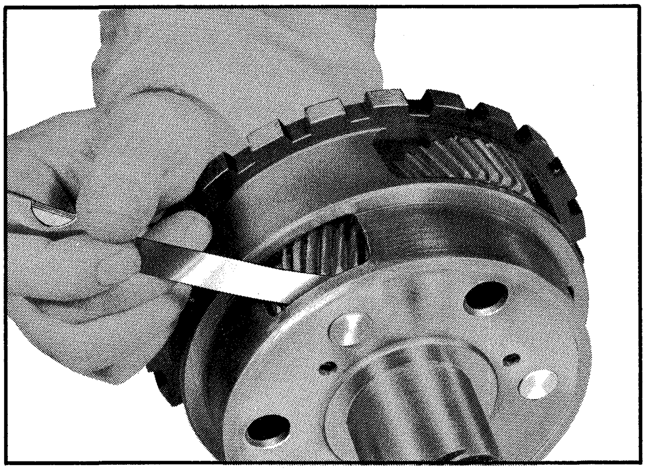


Fig. 7B-85 Checking Planet Pinion End Clearance

4. Check input sun gear for tooth damage.

5. Inspect output shaft bearing surface for nicks or scoring.

6. Inspect output shaft splines for nicks or damage. To disassemble the planet carrier to replace worn or damaged parts, proceed as follows:

DISASSEMBLY

1. Remove planet pinion shaft lock plate screws and lockwashers (Fig. 7B-86).

2. Rotate lock plate clockwise and remove.

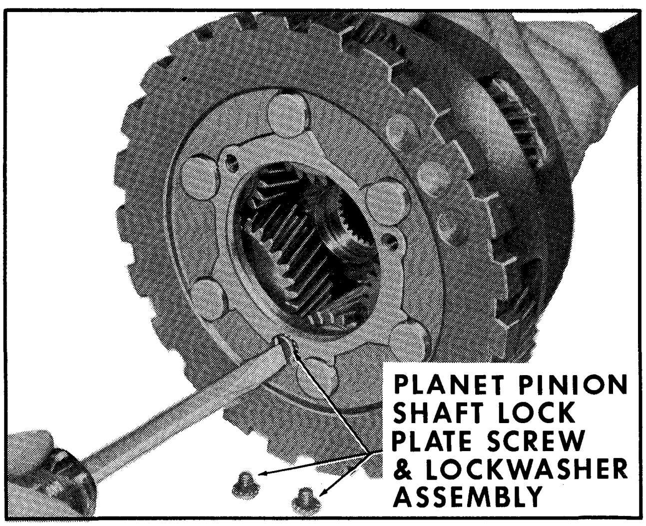



Fig. 7B-86 Removing Lock Plate Screws

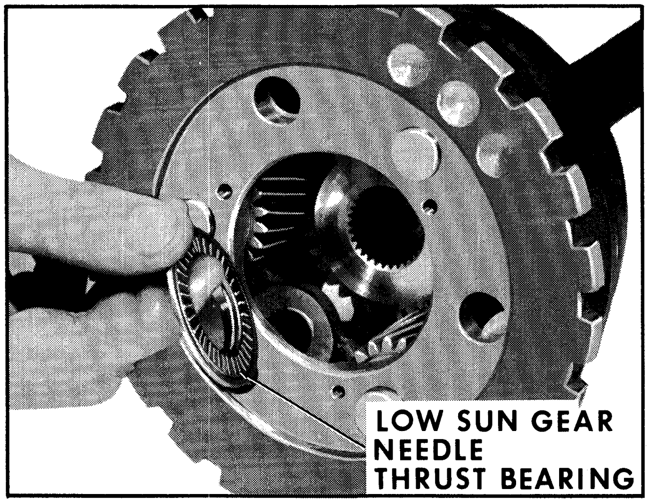



Fig. 7B-87 Removing Low Sun Gear Needle Thrust Bearing

*NOTE: If gears are to be reused, mark them in some convenient way so that they can be reinstalled in the original position, facing the original direction. If this is not done, the gear set may be noisy.*

3. Starting with a short planet pinion, push out the pinion shaft. Remove pinion, needle bearings, and thrust washers.

4. Repeat step 3 to remove remaining two short pinions.

5. Remove low sun gear needle thrust bearing (Fig. 7B-87).

6. Remove input sun gear (Fig. 7B-88).

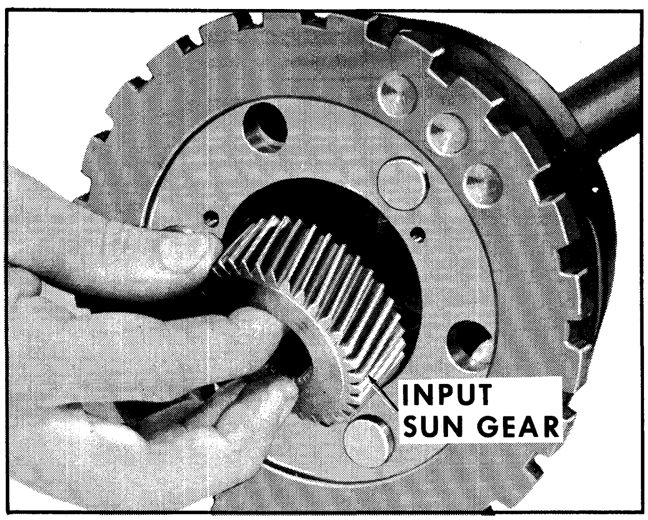



Fig. 7B-88 Removing Input Sun Gear

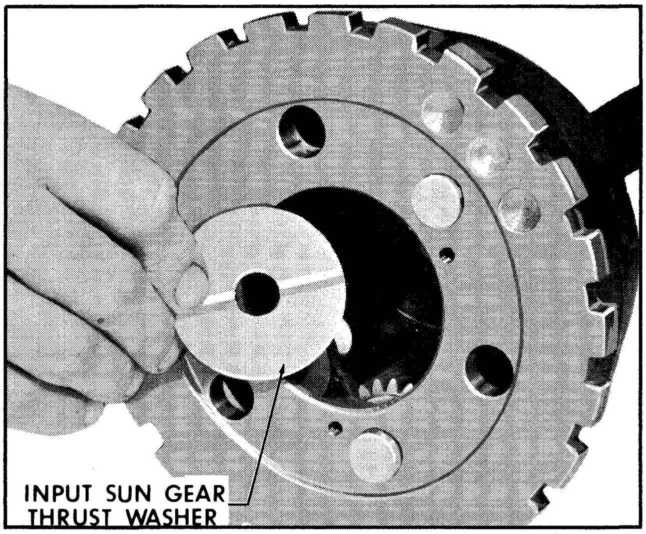



Fig. 7B-89 Removing Input Sun Gear Thrust Washer

7. Remove input sun gear thrust washer (Fig. 7B-89).

8. Remove three long pinion shafts, pinions, bearings, and thrust washers.

INSPECTION

1. Wash all parts in cleaning solvent and air dry.

2. Recheck pinions and input sun gear for nicks or other tooth damage. Check needle thrust bearing and all thrust washers for wear. Replace worn or damaged parts.

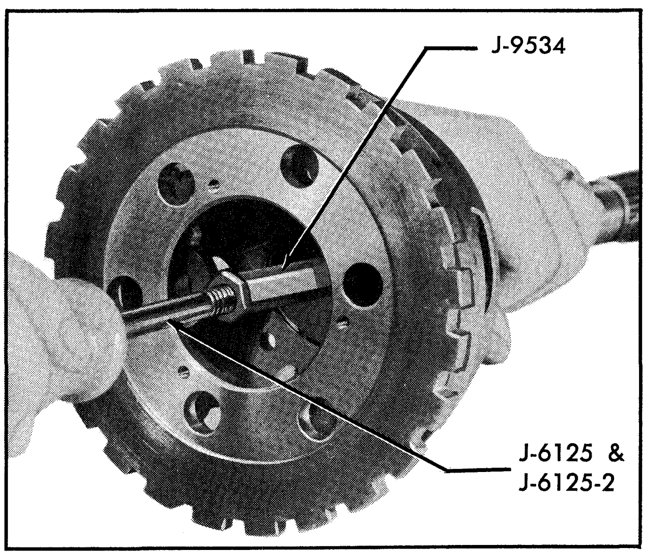



Fig. 7B-90 Removing Output Shaft Bushing

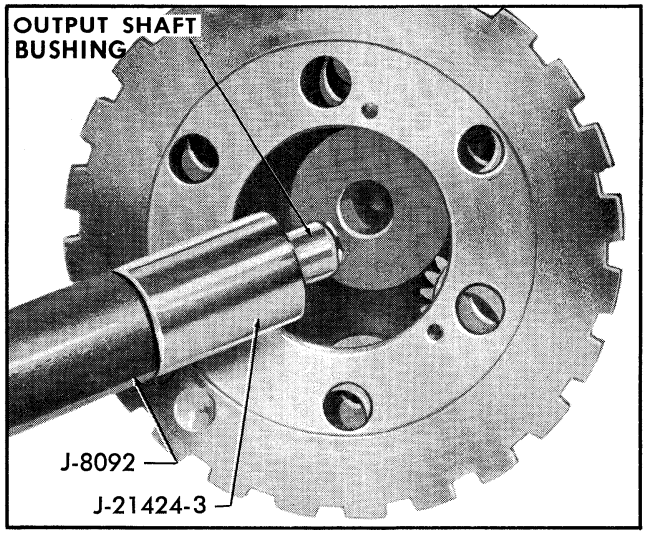



Fig. 7B-91 Installing Output Shaft Bushing

3. Inspect pinion needle bearings carefully. If worn, all needle bearings must be replaced. Replace worn pinion shafts.

4. Check output shaft bushing for nicks, severe scoring, or wear. If replacement is required, proceed as follows:

OUTPUT SHAFT BUSHING REPLACEMENT

1. Install bushing remover J-9534 into bushing. Install slide hammer into J-9534 and remove bushing (Fig. 7B-90).

2. Using installer J-21424-3 and handle J-8092, press new bushing into output shaft until J-21424-3 touches machined surface of carrier assembly (Fig. 7B-91).

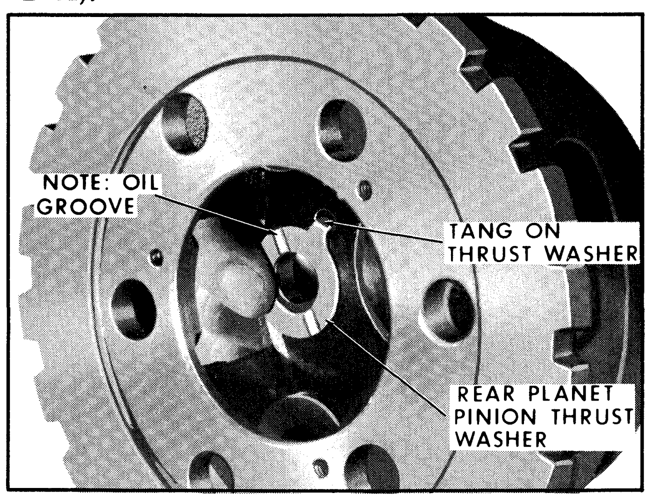



Fig. 7B-92 Installing Long Pinion Rear Thrust Washer

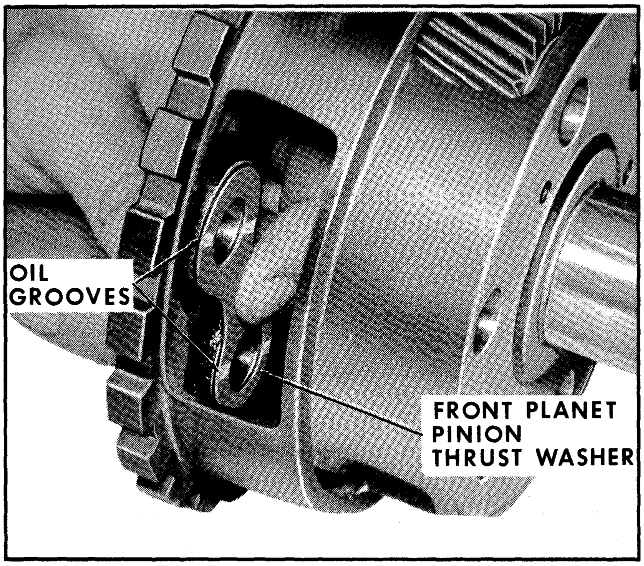



Fig. 7B-93 Installing Long Pinion Front Thrust Washer

ASSEMBLY

1. Install long pinions first. Install pinion rear thrust washer, retaining it with petrolatum. Oil groove must face pinion; engage washer tang in hole (Fig. 7B-92).

2. Install pinion front thrust washer ("paired" washer), retaining it with petrolatum. Oil grooves must face pinion (Fig. 7B-93).

3. Install 20 needle bearings, spacer, 20 more needle bearings, and two thrust washers into long pinion (Fig. 7B-94). A small amount of petrolatum will aid in holding needle bearings and washers in place.

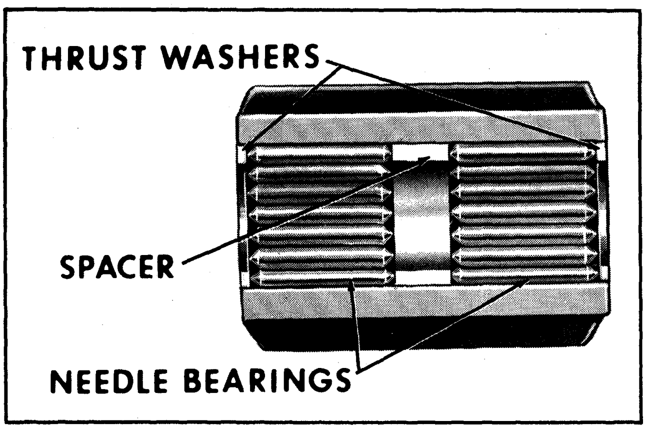



Fig. 7B-94 Long Pinion and Bearing Assembly

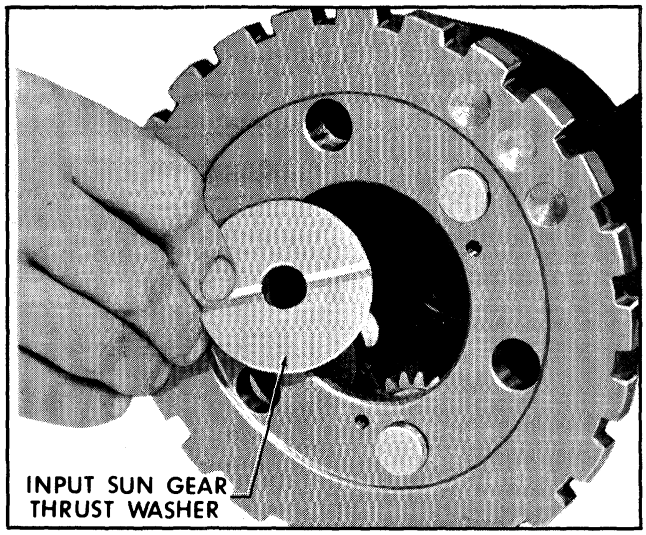



Fig. 7B-95 Installing Input Sun Gear Thrust Washer

4. Hold long pinion and needle bearing assembly in position and install long pinion shaft from front of planet carrier. As shaft is pushed in, make certain that it picks up thrust washers. Turn pinion shaft so that lock plate slot faces center of planet carrier.

*NOTE: Repeat steps 1 through 4 above to install remaining two long pinions.*

5. Install input sun gear thrust washer with oil groove facing input gear (Fig. 7B-95).

6. Install input sun gear.

7. Install low sun gear needle thrust bearing with bearings facing input sun gear (Fig. 7B-96).

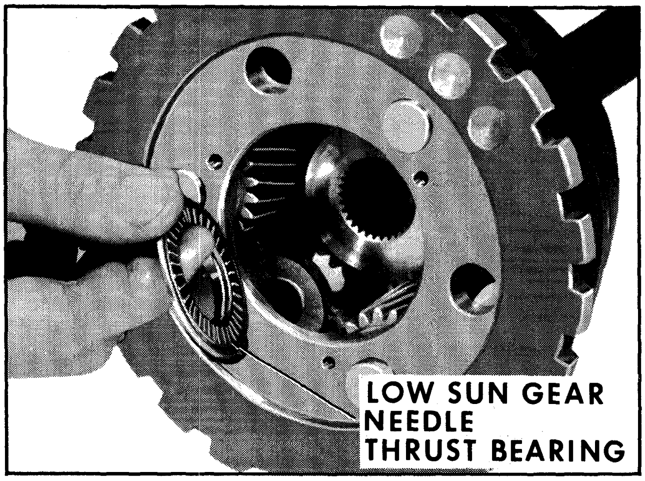



Fig. 7B-96 Installing Low Sun Gear Needle Thrust Bearing

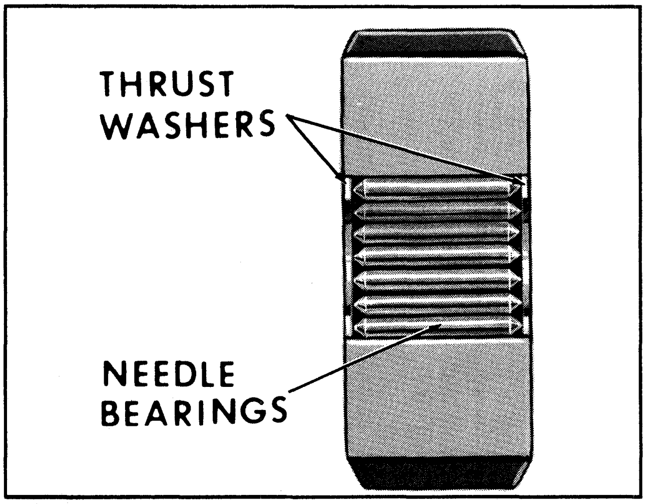



Fig. 7B-97 Short Pinion and Bearing Assembly

8. Install short pinion thrust washer with oil grooves facing pinion and retain with petrolatum. Position short pinion half of adjacent "paired" thrust washer and retain with petrolatum.

9. Install 20 needle bearings and two thrust washers in short planet pinion (Fig. 7B-97). Retain with petrolatum.

10. Hold short pinion and needle bearing assembly in position and install short pinion shaft from front of planet carrier. As shaft is pushed in, make certain that it picks up thrust washers. Turn pinion shaft so that lock plate slot faces center of planet carrier.

*NOTE: Repeat steps 8 through 10 above to install remaining two short pinions.*

11. Install planet pinion lock plate. Rotate plate so that tabs align with slots in planet pinion shafts and the three attaching screw holes. Install screw and lockwasher assemblies and tighten securely.

### *LOW SERVO ASSEMBLY*

DISASSEMBLY

*CAUTION: The low servo assembly spring pressure is very high. Use extreme care when disassembling or assembling.*

1. Support piston in vise or on arbor press base so that piston and rod retainer is accessible for removal. Exert pressure on piston rod until retainer can be removed.

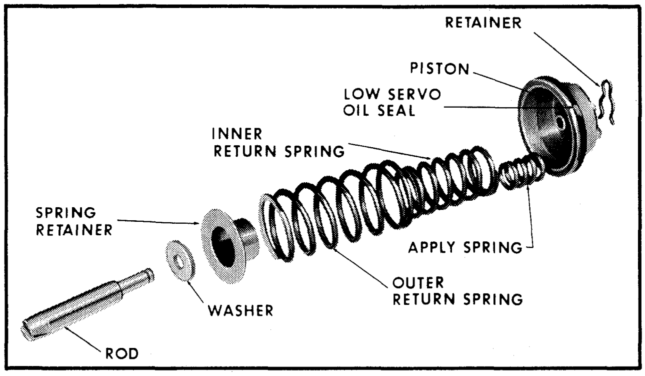



Fig. 7B-98 Low Servo Assembly - Exploded View

2. Remove retainer and release pressure slowly. Separate parts of assembly (Fig. 7B-98).

INSPECTION AND REPAIR

Visually examine parts for damage or wear. Discard worn or damaged parts. Remove and discard piston oil seal ring.

ASSEMBLY

1. Assemble low servo parts, using Fig. 7B-98 as a guide.

2. Compress assembly in a vise or arbor press and install retainer.

3. Remove assembly from vise or arbor press and install new oil seal ring.

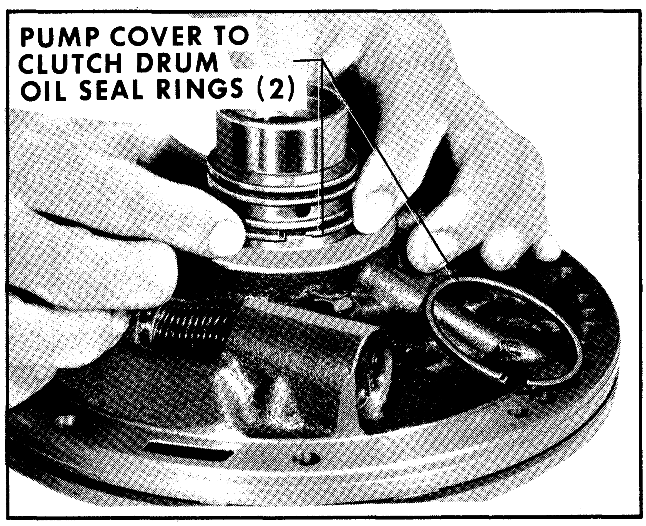



Fig. 7B-99 Removing Oil Seal Rings

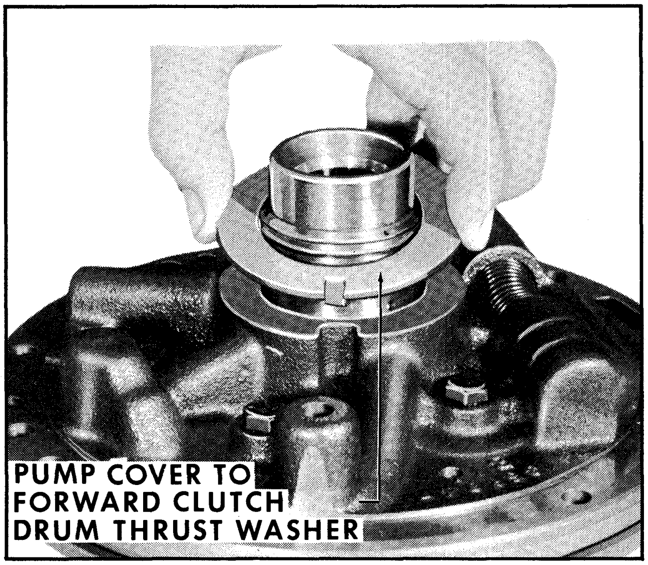



Fig. 7B-100 Removing Thrust Washer

***OIL PUMP***

DISASSEMBLY

1. Remove the two hook type oil seal rings from pump hub (Fig. 7B-99).

2. Remove pump cover to forward clutch drum thrust washer (Fig. 7B-100).

3. Remove and discard oil pump to case seal.

4. Support oil pump on wood blocks. Remove five pump cover bolts and remove pump cover.

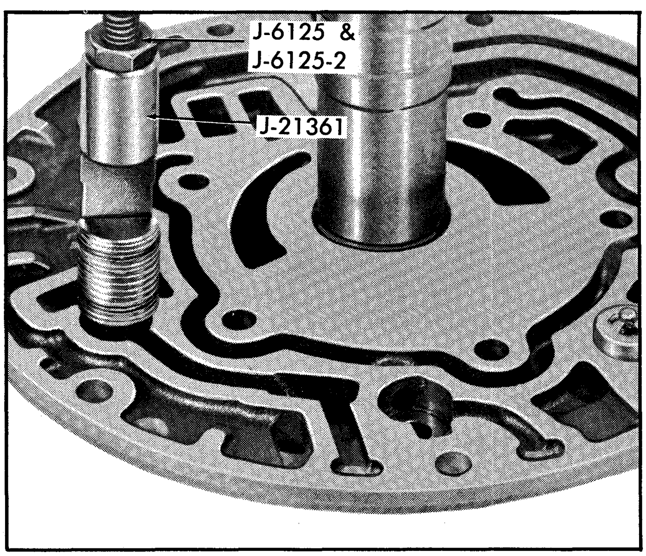



Fig. 7B-101 Removing Check Valve Seat

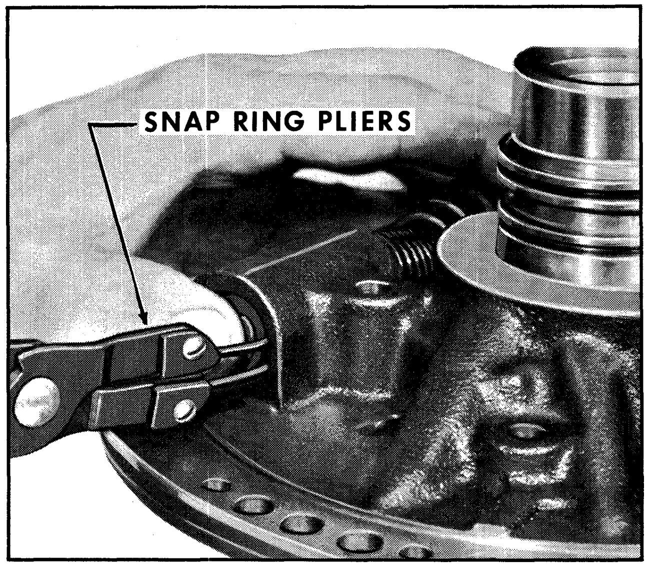



Fig. 7B-102 Removing Boost Valve Sleeve Snap Ring

5. Identify gear faces so that gears can be reassembled with faces in original position and remove drive and driven gears.

6. If necessary, remove cooler by-pass (V-8 only) and lube blow-off check valve seats using tool J-21361 (Fig. 7B-101). Remove valves and springs.

*CAUTION: Valve spring is under high pressure. Use extreme care after snap ring has been removed in step 7 below.*

7. Compress main pressure regulator valve spring by pressing on boost valve sleeve with thumb and remove retaining snap ring (Fig. 7B-102).

8. Remove boost valve sleeve, valve, spring, washer and pressure regulator valve (Fig. 7B-103).

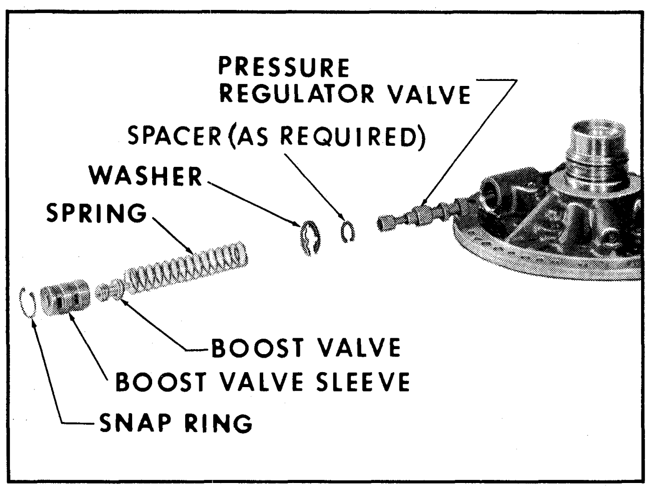



Fig. 7B-103 Main Pressure Regulator - Exploded View

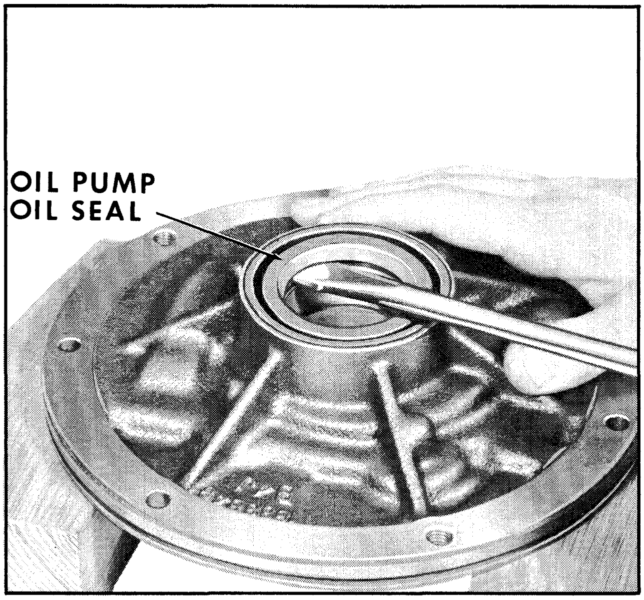



Fig. 7B-104 Removing Oil Pump Oil Seal

9. Remove oil pump seal with a small pry bar and discard seal (Fig. 7B-104).

INSPECTION

1. Check oil pump bushing for nicks, severe scoring or wear. If replacement is necessary, replace pump body assembly; bushing is not replaceable.

2. Check stator shaft bushing for nicks, severe scoring or wear. If replacement is necessary, see STATOR SHAFT BUSHING REPLACEMENT below.

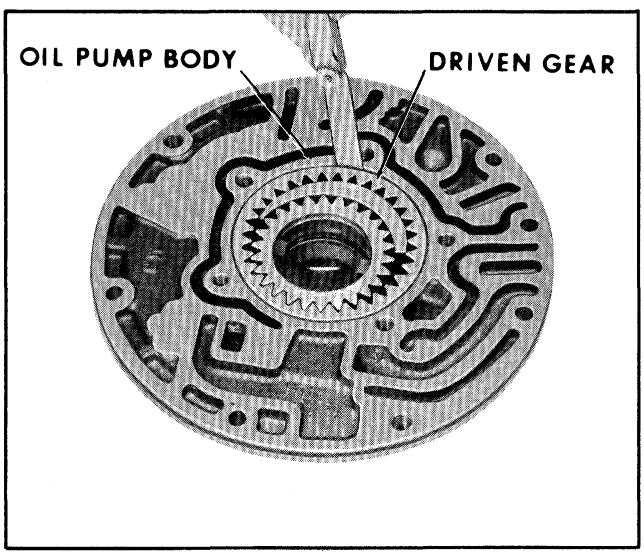



Fig. 7B-105 Checking Driven Gear to Body Clearance

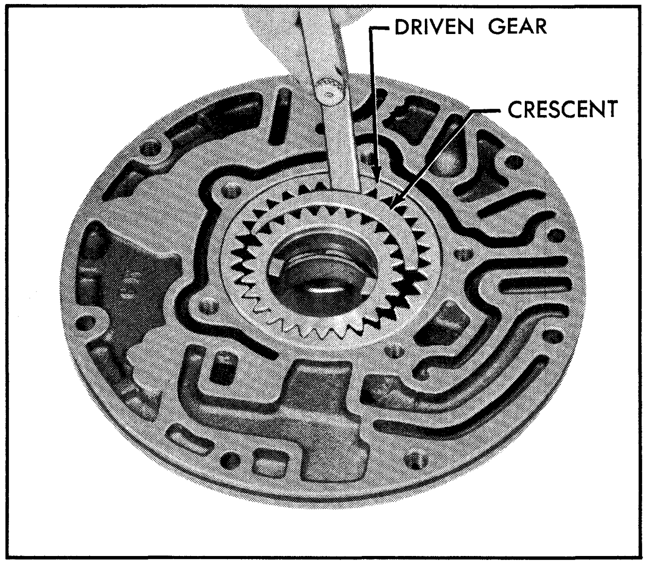



Fig. 7B-106 Checking Driven Gear to Crescent Clearance

3. Inspect pump gears for nicks or damage.

4. Inspect pump body for nicks or scoring.

5. Install oil pump gears and check clearance between driven gear and pump body (Fig. 7B-105). Correct clearance is .0035" to .0065".

6. Check clearance between oil pump driven gear and crescent (Fig. 7B-106). Correct clearance is .005" to .0100".

7. Check clearance between oil pump drive gear and crescent (Fig. 7B-107). Correct clearance is .004" to .009".

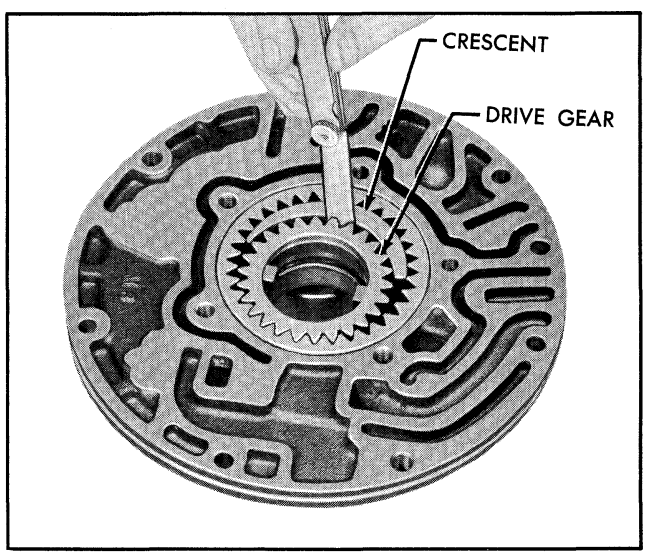



Fig. 7B-107 Checking Drive Gear to Crescent Clearance

Fig. 7B-108 Checking Gear End Clearance

8. With dial indicator set, check end clearance (Fig. 7B-108). Correct end clearance is .0005" to .0015".

9. Inspect pressure regulator valve and boost valve and sleeve for nicks or burrs.

STATOR SHAFT BUSHING REPLACEMENT

1. While holding front end of stator shaft in one hand, use tool J-21424-7, a suitable brass drift, and a hammer to drive bushing out of front end of stator shaft (Fig. 7B-109).

2. Using tool J-21424-7, drive new bushing into stator shaft until it just bottoms (Fig. 7B-110). Do not overdrive.

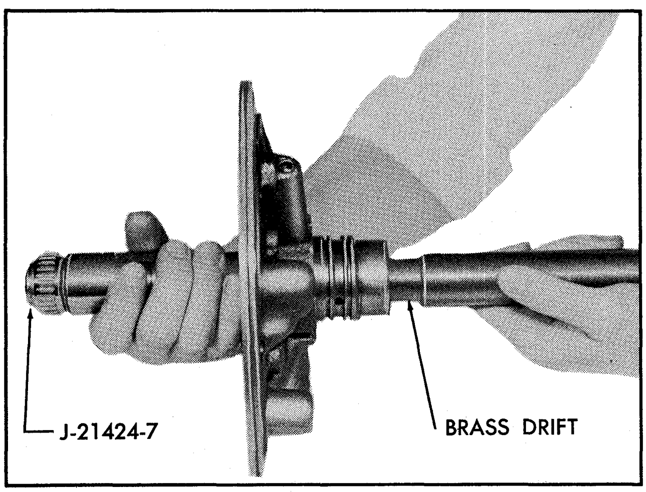



Fig. 7B-109 Removing Stator Shaft Bushing

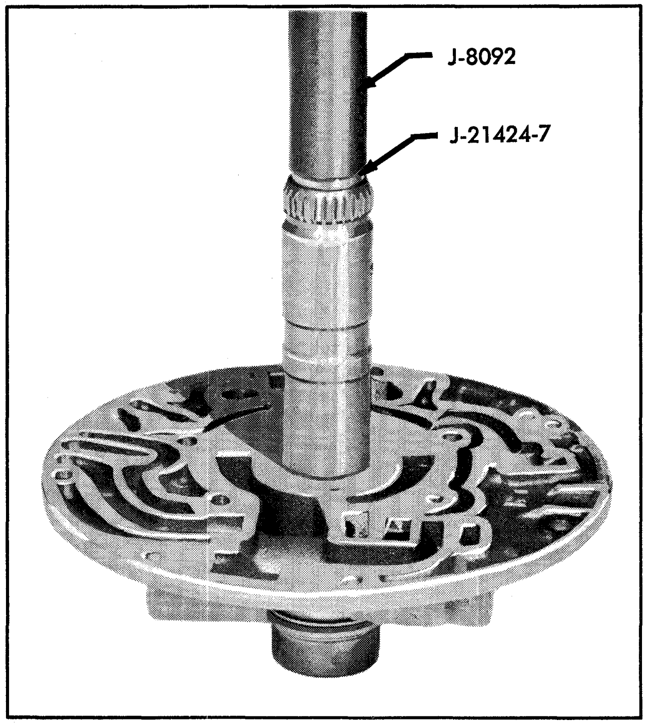



Fig. 7B-110 Installing Stator Shaft Bushing

ASSEMBLY

1. Using tool J-21359 install new oil seal (Fig. 7B-111).

2. Install new oil pump to case seal.

3. Assemble pressure regulator valve, washer, spring boost valve and sleeve (Fig. 7B-112).

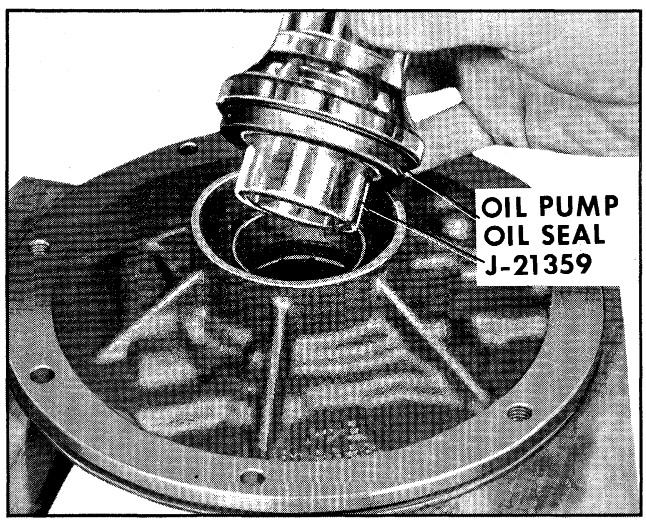



Fig. 7B-111 Installing Oil Pump Oil Seal

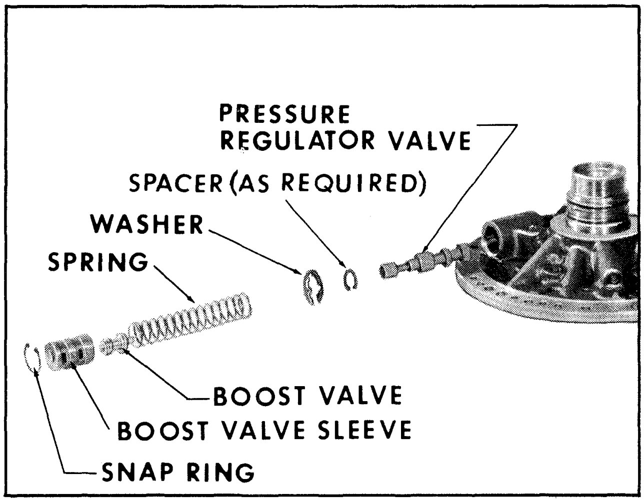



Fig. 7B-112 Main Pressure Regulator - Exploded View

*NOTE: Later production transmissions incorporate a C type spring washer and may have one or two C type spacers behind the washer. Install the same number of spacers originally removed.*

4. Compress pressure regulator valve spring by pressing on boost valve sleeve. Install snap ring.

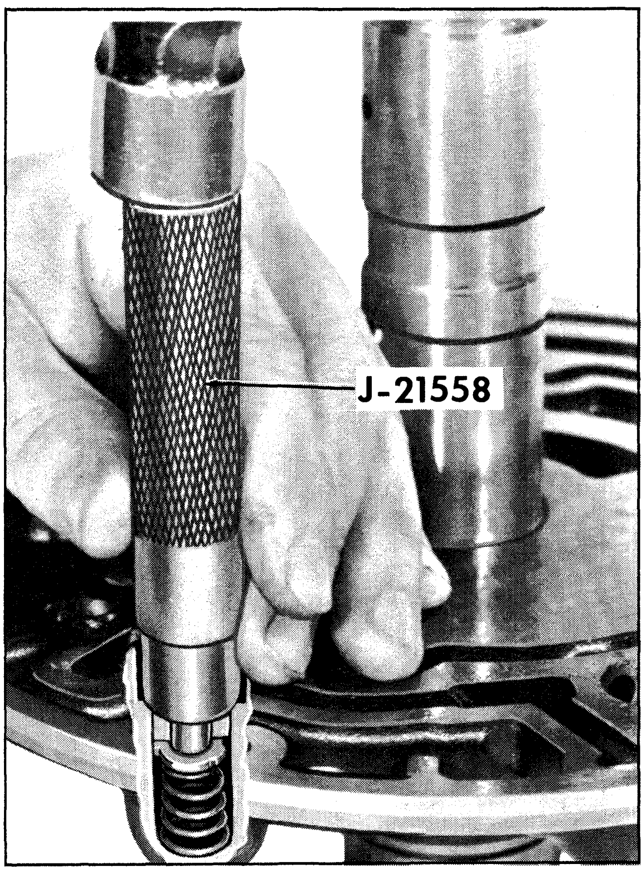



Fig. 7B-113 Installing Check Valve Seat

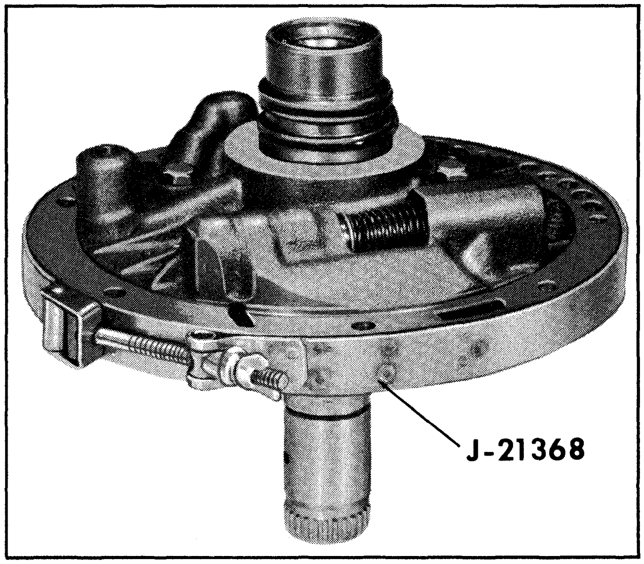



Fig. 7B-114 Aligning Oil Pump and Cover

5. If previously removed, install cooler by-pass (V-8 only) and lube blow-off valve springs, valves, and valve seats. Using tool J-21558, press valve seats into pump body bores until tool bottoms on face of pump (Fig. 7B-113).

*NOTE: Thrust washer and oil pump oil sealing rings will be installed during a later operation.*

6. Assemble pump body and cover. Install five retaining bolts, but do not tighten. Align pump body and cover with tool J-21368 (Fig. 7B-114). Tighten bolts to 16-24 lb. ft. torque. Remove tool J-21368.

### CONVERTER LEAK TEST

1. Install tool J-21369 and tighten.

2. Fill converter with air at a pressure of 80 psi.

3. Submerge in water and check for leaks.

### CONVERTER END PLAY CHECK

1. Fully release collet of tool J-21371 by turning screw clockwise.

2. Install collet end of J-21371 into converter until it bottoms.

3. While holding J-21371 with a wrench applied to flats on upper end, tighten screw by turning counterclockwise until collet firmly grips converter internal assembly.

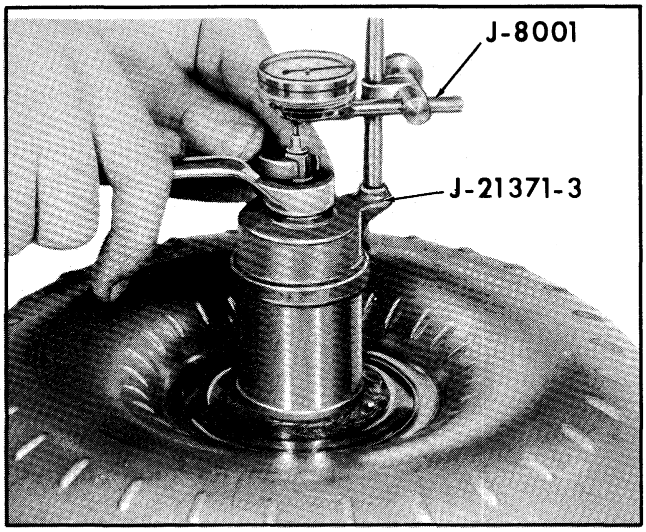



Fig. 7B-115 Checking Converter End Clearance

4. Install dial indicator holding fixture and tighten hex nut to raise converter internal assembly, which is gripped by collet. (Fig. 7B-115).

5. When hex nut of J-21371 has been tightened firmly, install dial indicator and adjust for zero reading while plunger rests on end of screw.

6. Loosen hex nut, allowing converter internal assembly to lower until dial indicator shows internal assembly has bottomed. Acceptable end clearance is .050" or less.

## TRANSMISSION REASSEMBLY

### *GENERAL*

Before starting to assemble the transmission make certain that all parts are absolutely clean. Keep hands and tools clean to avoid getting dirt into assembly. If work is stopped before assembly is completed, cover all openings with clean cloths.

Lightly coat all moving parts with transmission oil before installation. Thrust washers may be held in place with petrolatum sparingly applied.

Do not take a chance on used gaskets and seals - use new ones to avoid oil leaks.

Use care to avoid making nicks or burrs on parts, particularly at bearing surfaces and surfaces where gaskets are used.

It is extremely important to tighten all parts evenly to avoid distortion of parts and leakage at gaskets and other joints. Use a reliable torque wrench to tighten all bolts and nuts to specified torque.

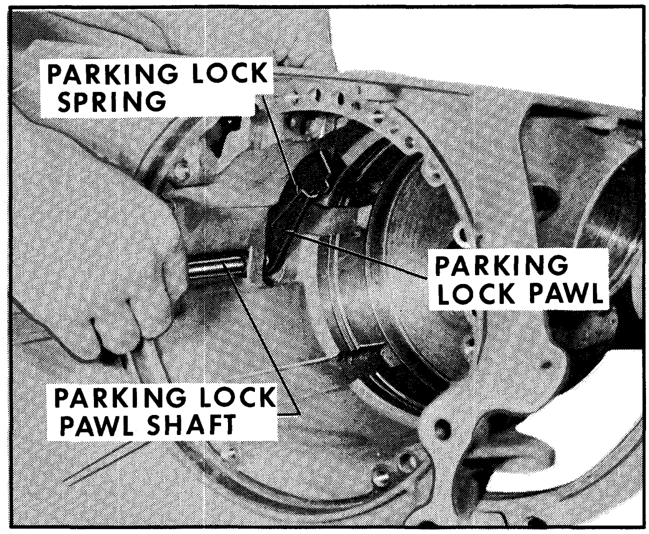



Fig. 7B-116 Installing Parking Lock Pawl Shaft

### *INSTALLATION OF RANGE SELECTOR LEVER, SHAFT, AND PARKING LOCK ACTUATOR*

1. Hold parking lock pawl and spring in position and retain with parking lock pawl shaft (Fig. 7B-116).

2. Install range selector shaft into case with a twisting motion.

3. Install inner park lock and range selector assembly on range selector shaft and secure with nut (Fig. 7B-117).

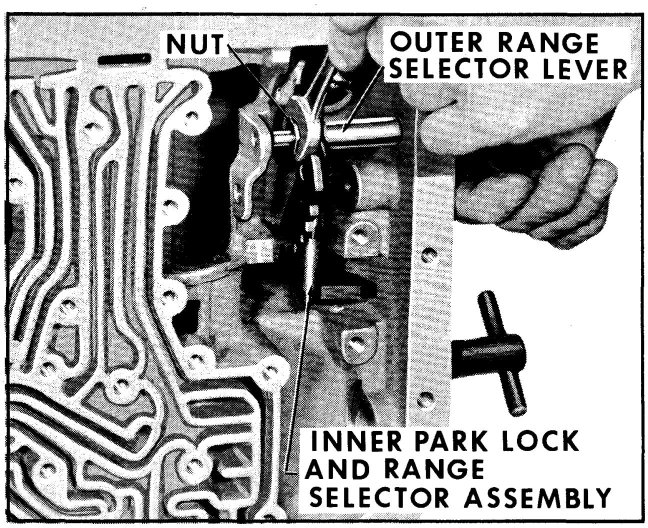



Fig. 7B-117 Installing Inner Park Lock and Range Selector Assembly

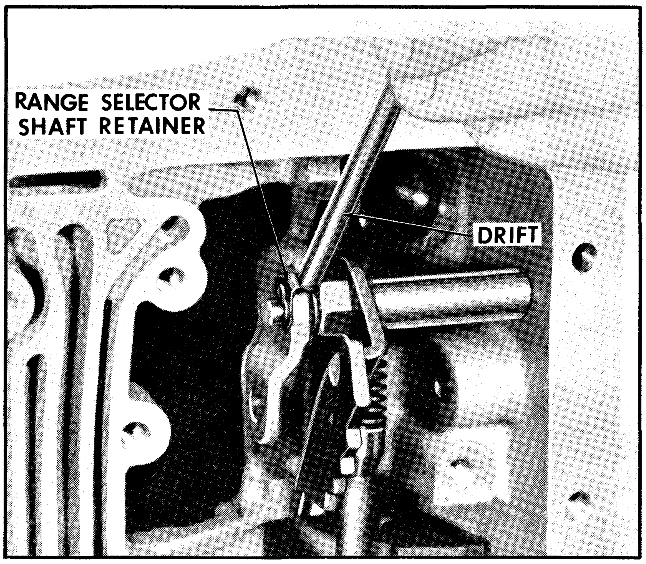



Fig. 7B-118 Installing Range Selector Shaft Retainer

*NOTE: Make certain that shorter end of outer lever is to bottom of transmission.*

4. Install range selector shaft retainer (Fig. 7B-118).

5. Install parking lock bracket in case and tighten bolts to 8-12 lb. ft. torque (Fig. 7B-119).

### INSTALLATION OF REVERSE PISTON AND CLUTCH

1. With transmission in vertical position install reverse clutch piston into case, making certain it bottoms in case.

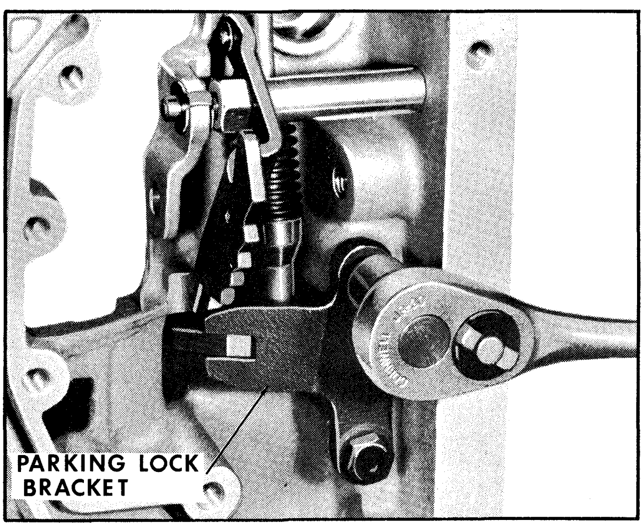



Fig. 7B-119 Installing Parking Lock Bracket

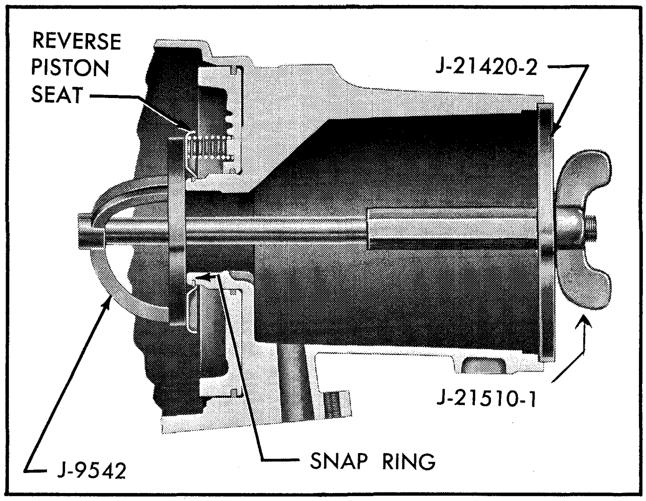



Fig. 7B-120 Compressing Reverse Piston Return Springs

2. Install clutch piston return springs.

3. Position piston return seat on piston return springs. Place snap ring in position on return seat so that ring can be easily installed when seat is compressed with tool.

4. Compress reverse piston return springs using spring compressor J-9542 and adapters until snap ring groove is exposed, (Fig. 7B-120). Install snap ring and remove tool.

*NOTE: Make certain inner edge of seat does not hang up on snap ring groove while springs are being compressed.*

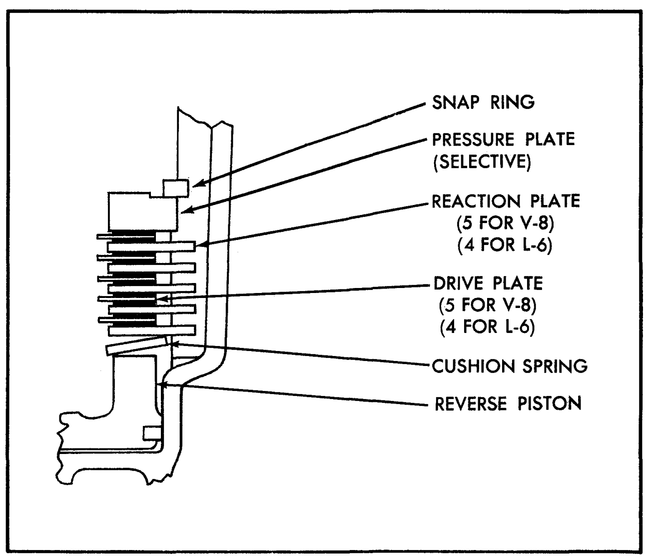



Fig. 7B-121 Reverse Clutch Pack Assembly Sequence

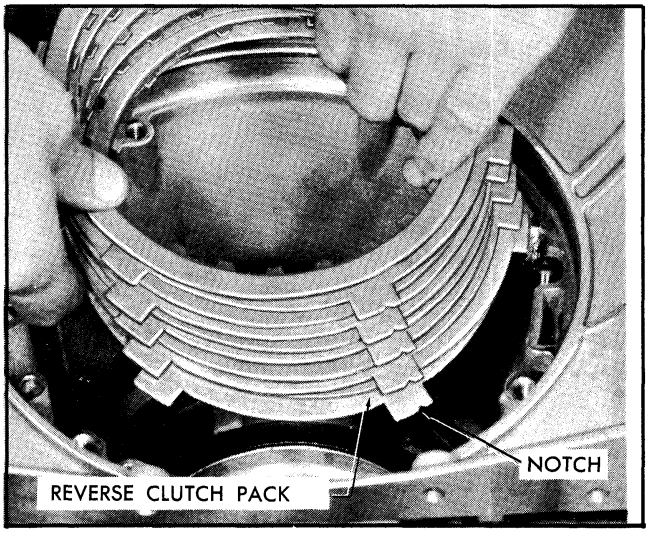



Fig. 7B-122 Installing Reverse Clutch Pack

5. Install reverse clutch cushion spring, reaction plates, and drive plates as shown in Fig. 7B-121. Notched lug in each steel reaction plate is installed so that it is at top of groove at 5 o'clock position in case (Fig. 7B-122).

6. Install pressure plate (Fig. 7B-123). The pressure plate has one, two or three rectangular "dimples" in lug that engages 5 o'clock case groove. Number of "dimples" (marks) is code for plate thickness.

7. Install reverse clutch pack snap ring.

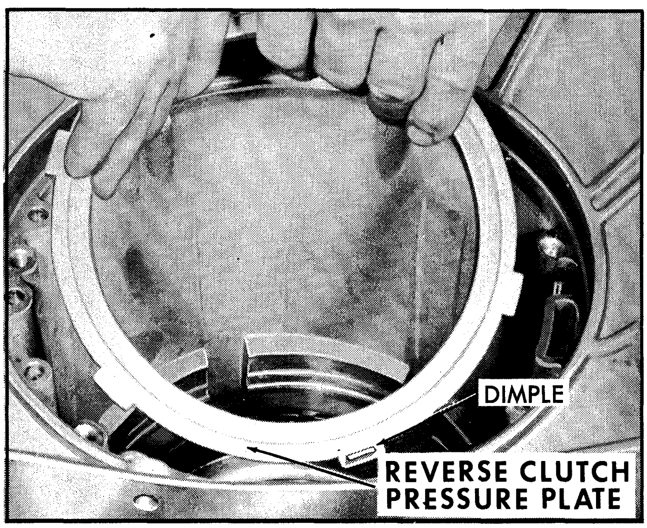



Fig. 7B-123 Installing Reverse Clutch Pressure Plate

| Part No. | Total Thickness | No. of Ident. Marks on Lug |
|---|---|---|
| 6257025 | .316-.326 | 1 |
| 1362967 | .348-.358 | 2 |
| 1362968 | .380-.390 | 3 |

Fig. 7B-124 Reverse Clutch Pressure Plate Chart

8. Insert feeler gauge between any reaction plate and adjacent drive (faced) plate. If clearance is .025" to .060", running clearance is correct. If clearance is not within these limits, refer to chart in Fig. 7B-124 to select correct thickness of pressure plate to adjust running clearance.

***INSTALLATION OF PLANETARY GEAR SET***

1. Install thrust bearing race with lip, needle bearing, and plain race on output shaft (Fig. 7B-125). Retain on rear face of planet carrier with petrolatum. (Bearing and races can be installed on case reverse clutch piston hub, if desired.)

2. Install reverse ring gear (Fig. 7B-126).

3. Install planetary gear seat.

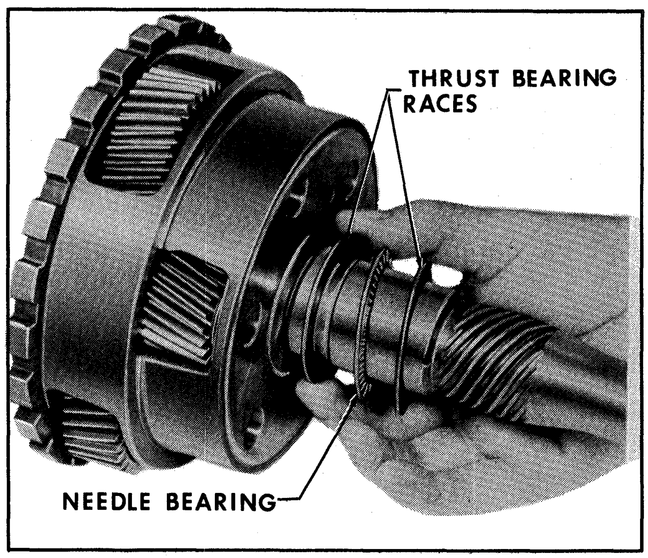



Fig. 7B-125 Installing Planet Carrier Thrust Bearing and Races

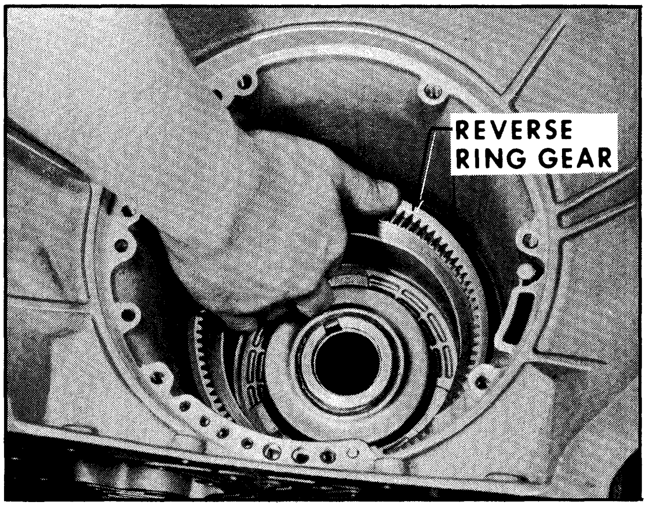



Fig. 7B-126 Installing Reverse Ring Gear

### *INSTALLATION OF LOW SERVO ASSEMBLY, LOW BAND, AND FORWARD CLUTCH*

LOW SERVO ASSEMBLY

1. Install low servo assembly into case. Position notch to receive low band strut.

2. Install new low servo cover oil seal and install cover.

3. Compress low servo cover with J-21495-1 and install snap ring (Fig. 7B-127).

4. Remove tool J-21495-1.

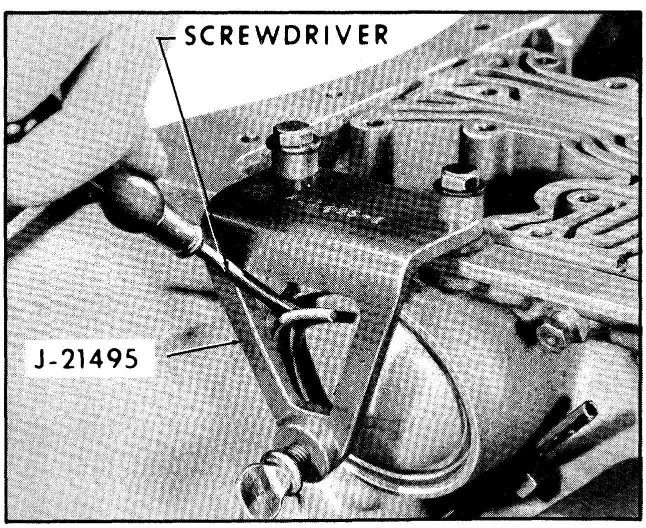



Fig. 7B-127 Installing Low Servo Cover Snap Ring

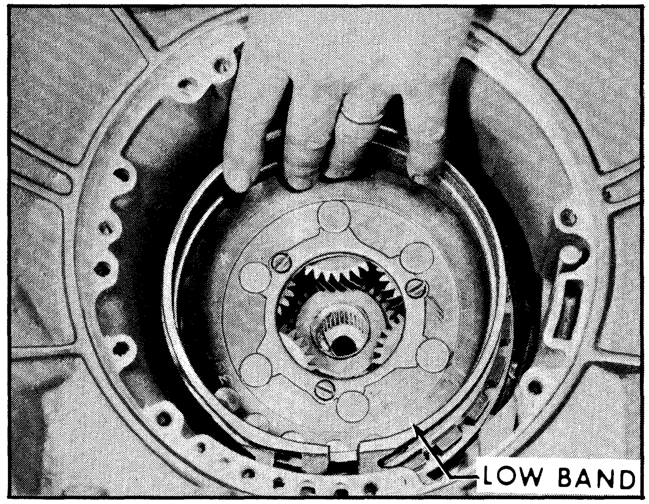



Fig. 7B-128 Installing Low Band

LOW BAND

1. With transmission in vertical position, install band adjusting screw.

2. Install low band (Fig. 7B-128).

3. Install low band apply strut and band adjusting screw strut (Fig. 7B-129). After both struts have been installed, tighten low band adjusting screw enough to prevent struts from falling out.

FORWARD CLUTCH

Install forward clutch assembly. (Fig. 7B-130) Turn slightly to engage low sun gear with planet pinions.

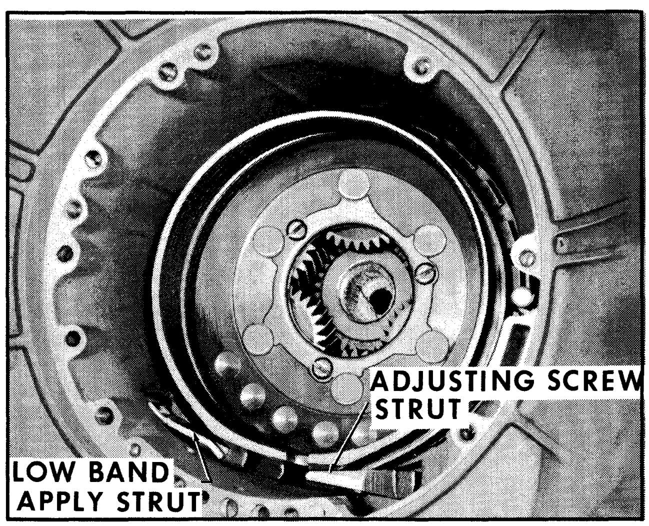



Fig. 7B-129 Low Band Struts Installed

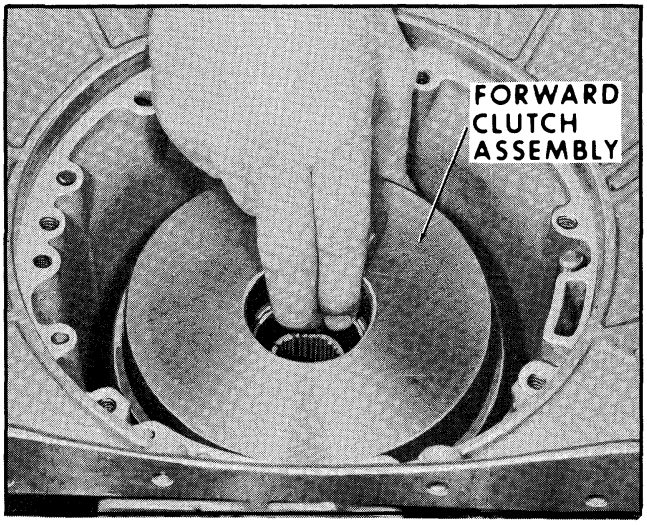



Fig. 7B-130 Installing Forward Clutch Assembly

*CAUTION: Make certain that the low sun gear needle thrust bearing assembly and the input sun gear rear thrust washer in the planet carrier are centered before installing the forward clutch assembly.*

### DETERMINATION OF SELECTIVE THRUST WASHER THICKNESS

The thickness of the oil pump to forward clutch assembly thrust washer is determined as follows:

1. Install guide pins and new pump gasket (Fig. 7B-131).

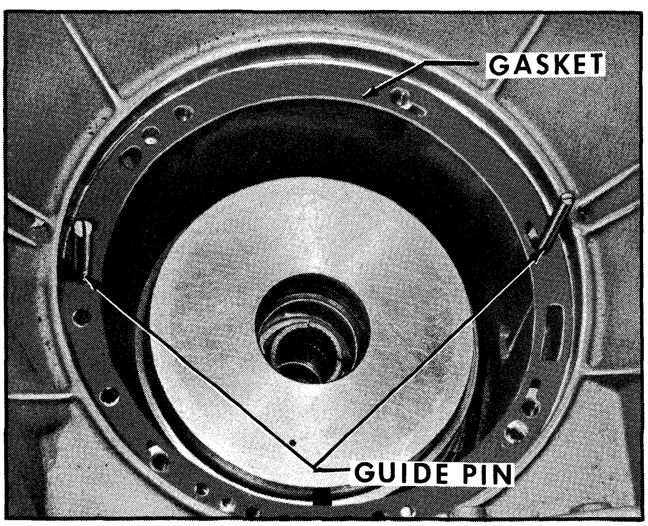



Fig. 7B-131 Guide Pins and Gasket Installed

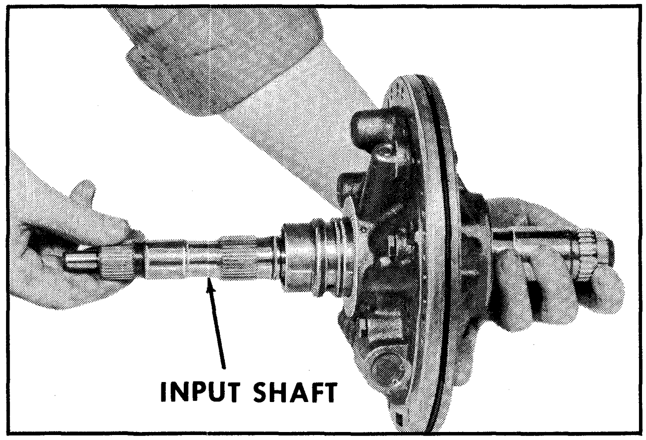



Fig. 7B-132 Installing Input Shaft Into Pump

2. Install input shaft into oil pump (Fig. 7B-132) and install oil pump (less oil seal rings, but with old or .061" thrust washer) into case.

3. Remove guide pins and install at least three oil pump retaining bolts. Tighten bolts to 16-24 lb. ft. torque.

4. With transmission in a vertical position, install a dial indicator so that its plunger bears on end of input shaft and zero the indicator.

5. Push up on output shaft and record amount of end play registered on dial indicator.

*NOTE: If end play is less than .008", check for improper assembly of parts.*

6. Refer to chart (Fig. 7B-133) and select correct thickness of thrust washer to establish a running clearance of .008"-.051". (If end play is more than .051" with .097" thrust washer installed, check for excessive wear of assembled parts or omitted thrust washers, races or bearings in or behind planet carrier.)

*NOTE: Selective thrust washers are available in three thicknesses: .061", .079", and .096" (±.002"). Since there are no identifying marks on these thrust washers, it will be necessary to measure thickness with a micrometer if thickness is in doubt.*

| If end Play is: | Correct Thrust Washer Thickness is: |
|---|---|
| .071" to .110" | .061" |
| .089" to .128" | .079" |
| .107" to .146" | .097" |

Fig. 7B-133 Selective Thrust Washer Chart

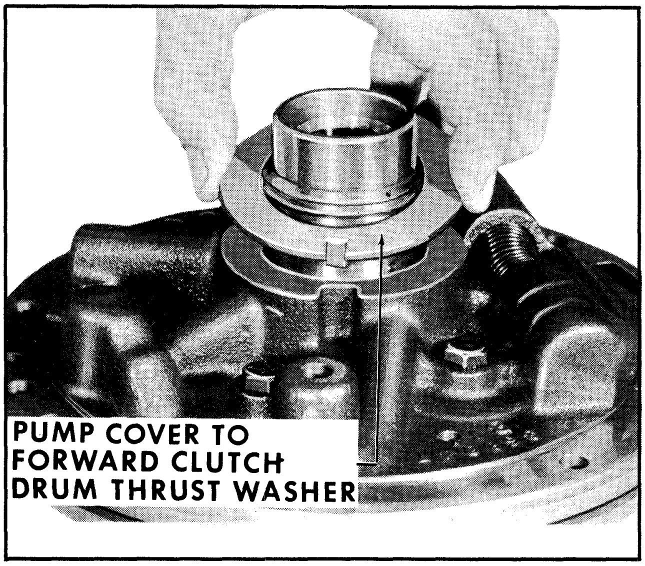



Fig. 7B-134 Installing Thrust Washer

7. Remove oil pump and input shaft and proceed in accordance with instructions in INSTALLATION OF OIL PUMP below.

### INSTALLATION OF OIL PUMP

1. Install selective thrust washer on pump hub (Fig. 7B-134). See DETERMINATION OF SELECTIVE THRUST WASHER THICKNESS above.

2. Install two hook type oil seal rings on pump hub (Fig. 7B-135). Make certain rings are free to move in grooves.


Fig. 7B-135 Installing Oil Seal Rings

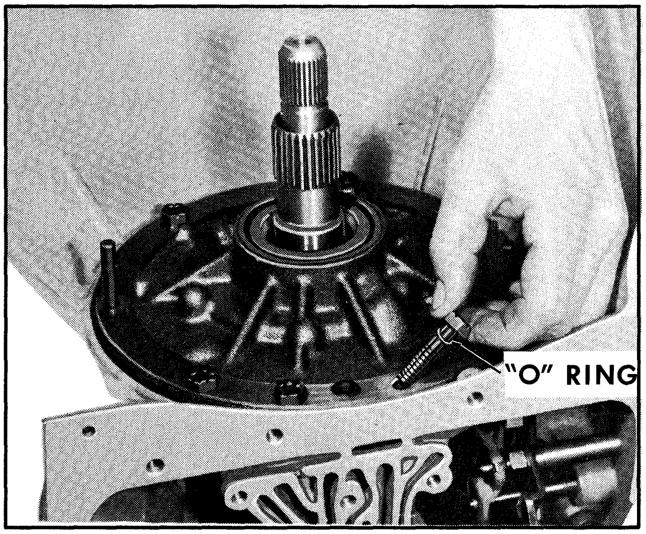



Fig. 7B-136 Installing Oil Pump Retaining Bolts

3. Install guide pins and new pump gasket (Fig. 7B-131).

4. Install two input shaft hook type oil seal rings. Make certain rings are free to move in grooves.

5. Install input shaft into oil pump (Fig. 7B-132) and install oil pump into case. (Make certain input shaft turns freely in pump before installing pump into case.)

6. Remove guide pins and install oil pump retaining bolts with new O-rings under head (Fig. 7B-136). Tighten bolts to 16-24 lb. ft. torque.

### LOW BAND ADJUSTMENT

1. Tighten low band adjusting screw to 40 ± 5 lb. in. torque.

2. Back off adjusting screw exactly four turns.

3. Hold adjusting screw and tighten lock nut.

4. Install adjusting screw cap.

### INSTALLATION OF SPEEDOMETER DRIVE GEAR

1. Place transmission in horizontal position and engage park lock.

2. Slide speedometer drive gear onto output shaft.

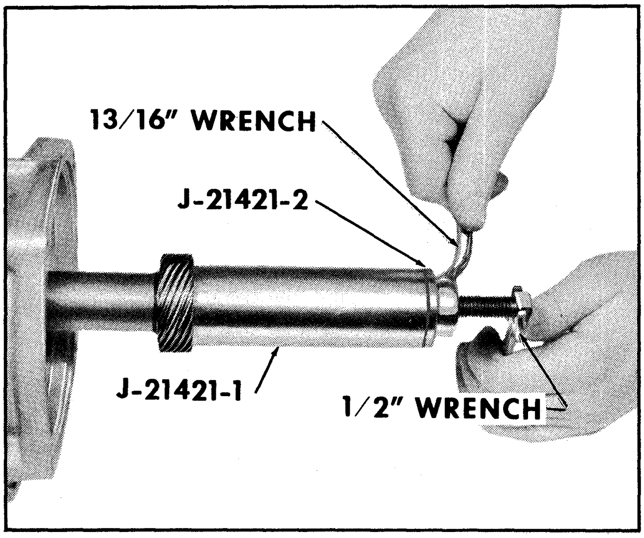



Fig. 7B-137 Installing Speedometer Drive Gear

3. Using tools J-21421-1 and J-21421-2, drive speedometer drive gear into position (Fig. 7B-137). When J-21421-2 bottoms on end of output shaft, drive gear location is correct.

### INSTALLATION OF REAR BEARING RETAINER, GOVERNOR, VACUUM MODULATOR, SPEEDOMETER DRIVEN GEAR, AND VALVE BODY

See SERVICE OPERATIONS -- TRANSMISSION IN CAR (page 7B-21).

### INSTALLATION OF CONVERTER

1. Install converter into transmission, engaging drive lugs of oil pump drive gear.

2. Install converter holding clamp J-21366.

## TROUBLE DIAGNOSIS

### NO UPSHIFT BELOW 50 MPH (UPSHIFTS ABOVE)

1. Vacuum line disconnected or leaking (causes abnormally high line pressure).

2. Failed modulator diaphragm (causes excessive exhaust smoke).

3. Downshift solenoid stuck in downshift position.

4. Downshift switch shorted or stuck.

5. Modulator valve stuck (causes erratic line pressure).

### NO FORCED DOWNSHIFT ABOVE 15 MPH

1. Downshift switch malfunction.

2. Downshift solenoid stuck closed.

3. Detent valve stuck.

### NO UPSHIFT AT ANY SPEED

1. Governor stuck or otherwise malfunctioning (results in normal pressure at 0 mph, but does not decrease normally with increased car speed).

2. Shift valve stuck (pressures appear normal).

### NO DOWNSHIFT

1. Shift valve stuck.

2. Servo piston broken.

### NO DRIVE—FORWARD OR REVERSE

1. Mechanical failure (line pressure is normal).

2. Mechanical failure in or ahead of pump (no line pressure).

3. Pressure regulator valve stuck (no line pressure).

4. Extremely low oil level.

### SLIPPING

1. Low oil level.

2. Failed modulator bellows (line pressure does not increase with decrease in engine vacuum and upshifts occur extremely early).

3. Pressure regulator valve stuck (low line pressure).

4. Modulator valve stuck (low line pressure).

5. Low band adjustment (slips in forward, normal in reverse).

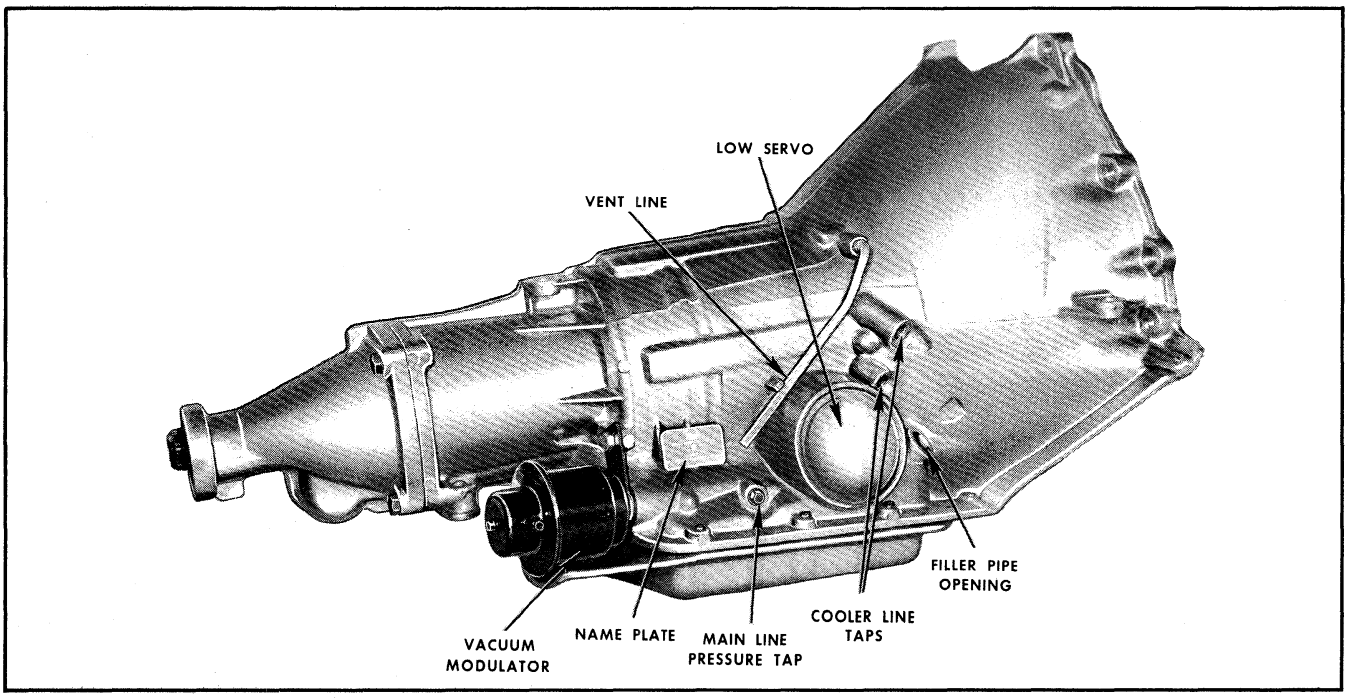



Fig. 7B-138 Mainline Pressure Tap

***SLIPS ON CORNERING OR AFTER QUICK STOP***

Low oil level.

## PRESSURE CHECKS

Pressure checks are a useful part of trouble diagnosis. The pressure tap for checking mainline pressure is located above the oil pan rail on the right side of the transmission and to the rear of the low servo (Fig. 7B-138).

All tests can be made without driving the vehicle by simply raising the rear wheels 3-5 inches from the floor on jack stands. With pressure gauge installed, perform the following preliminary steps:

- Establish pressure gauge indicator needle rest position at zero pressure.
- Thoroughly warm up transmission.
- Check transmission oil level.
- Make sure vacuum line connections are tight.
- Check linkage adjustment.

Mainline pressure will vary from one transmission to another but the following statements apply in general.

- Line pressure should increase as engine manifold vacuum decreases, at a constant speed.
- Line pressure should decrease as car speed increases, at a constant engine manifold vacuum (for example, about 13 psi between 40-60 MPH).
- Reverse pressure should be about 90 psi at idle to over 200 psi at stall (wide open throttle with brakes on).

  *NOTE: Do not operate at wide open throttle with brakes on longer than it is necessary to obtain a gauge reading.*

- Line pressure at wide open throttle upshift should be about 85-90 psi for Model 20, and approximately 100 psi for Model 30.
- Model 20 mainline pressure in Drive range should be 140-60 psi, depending on operating conditions; in Low range 90 psi is the minimum.
- Model 30 mainline pressure in Drive range should be 150-60 psi, depending on operating conditions, in Low range 90 psi is the minimum.

## TORQUE SPECIFICATIONS

| Location | Torque Lb. Ft. |
|---|---|
| Case to Cylinder Block Bolts | 30-40 |
| Flywheel to Converter Bolts | 30-40 |
| Converter Cover Pan to Case Screws | 8-12 |
| Case Cooler Line Fittings | 20-30 |
| Low Band Adjusting Screw Lock Nut | 20-30 |
| Pump Body to Pump Cover Bolts | 16-24 |
| Valve Body to Case Bolts | 8-11 |
| Solenoid to Valve Body Bolts | 8-12 |
| Vacuum Modulator Clamp Bolt | 8-12 |
| Pump Assembly to Case Bolts | 16-24 |
| Rear Bearing Retainer to Case Bolts | 25-35 |
| Oil Pan to Case Bolts | 10-12 |
| Speedometer Sleeve Clamp Bolt | 8-12 |
| Governor Cover Bolts | 8-12 |
| Park Lock Bracket Bolts | 8-12 |

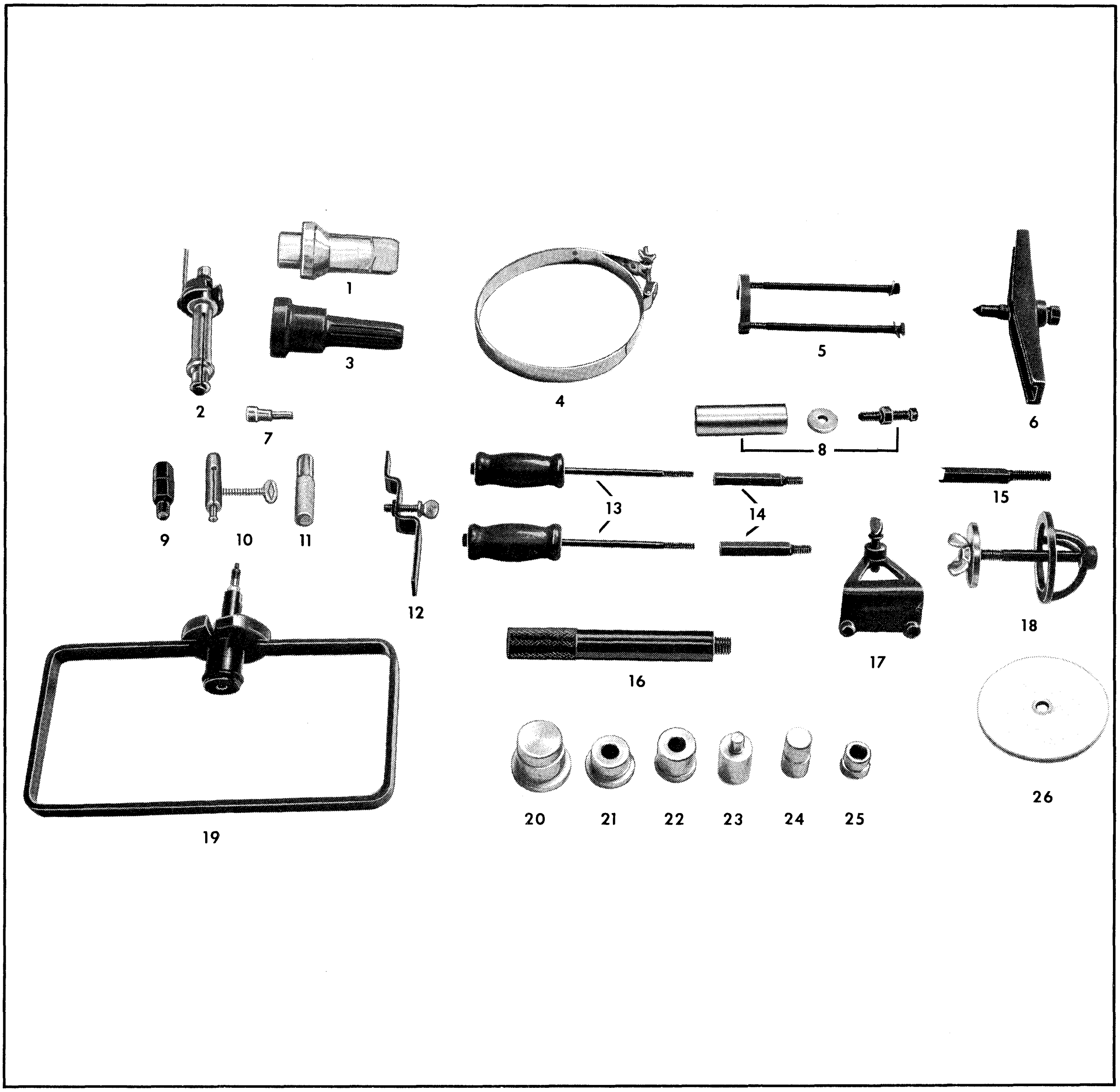



Fig. 7B-139 Special Tools

1. J-21359 Pump Oil Seal Installer
2. J-21371 Converter End Play Fixture
3. J-5154 Rear Oil Seal Installer
4. J-21368 Pump Body and Cover Alignment Band
5. J-21427 Speedometer Drive Gear Remover
6. J-8433 Puller (Use with J-21427)
7. J-8591 7/32" Allen Wrench (3/8" Square Drive)
8. J-21421 Speedometer Drive Gear Installer
9. J-9534 Planet Carrier Bushing Remover
10. J-21361 Pump Check Valve Seat Remover
11. J-21558 Check Valve Seat Installer
12. J-21366 Converter Holding Clamp
13. J-6125 Slide Hammer
14. J-6125-2 Slide Hammer Adapter
15. J-21510-1 Reverse Clutch Spring Compressor Screw Assembly
16. J-8092 Handle
17. J-21495 Low Servo Cover Remover and Installer
18. J-9542 Clutch Spring Compressor
19. J-21369 Converter Leak Test Fixture
20. J-21424-5 Forward Clutch Drum Bushing Remover and Installer
21. J-21424-2 Case Bushing Installer
22. J-21424-9 Rear Bearing Retainer Bushing Remover and Installer
23. J-21424-3 Planet Carrier Bushing Installer
24. J-21424-7 Stator Shaft Bushing Remover and Installer
25. J-21424-4 Low Sun Gear and Flange Assembly Bushing Remover and Installer
26. J-21420-2 Reverse Clutch Spring Compressor Pilot

# FUEL TANK AND EXHAUST

## CONTENTS OF THIS SECTION



# FUEL TANK

## DESCRIPTION

The fuel tank has a 21.5 gallon capacity and is constructed of two sheet metal sections welded together. The filler pipe is attached to the tank and is removable. The fuel tank is secured to the under side of the body by metal straps (Fig. 8-1).

The tank filler pipe is located on the left side for Station Wagons (Fig. 8-2) and the center rear on all other body styles. It is accessible through a spring hinge door. Fuel tanks on all models use a vented filler cap (Fig. 8-3).

## SERVICE PROCEDURES

TO DRAIN FUEL TANK

1. Insert a length of hose (Fig. 8-4 for details) into the gas tank, pipe nipple end first, until weighted end of hose rests on bottom of tank.

2. With chuck of air hose inserted into hose slit, a short blast of air will cause the gas to flow.

*NOTE: The tank can be drained rapidly by raising the car several feet off the floor when performing the above operation.*

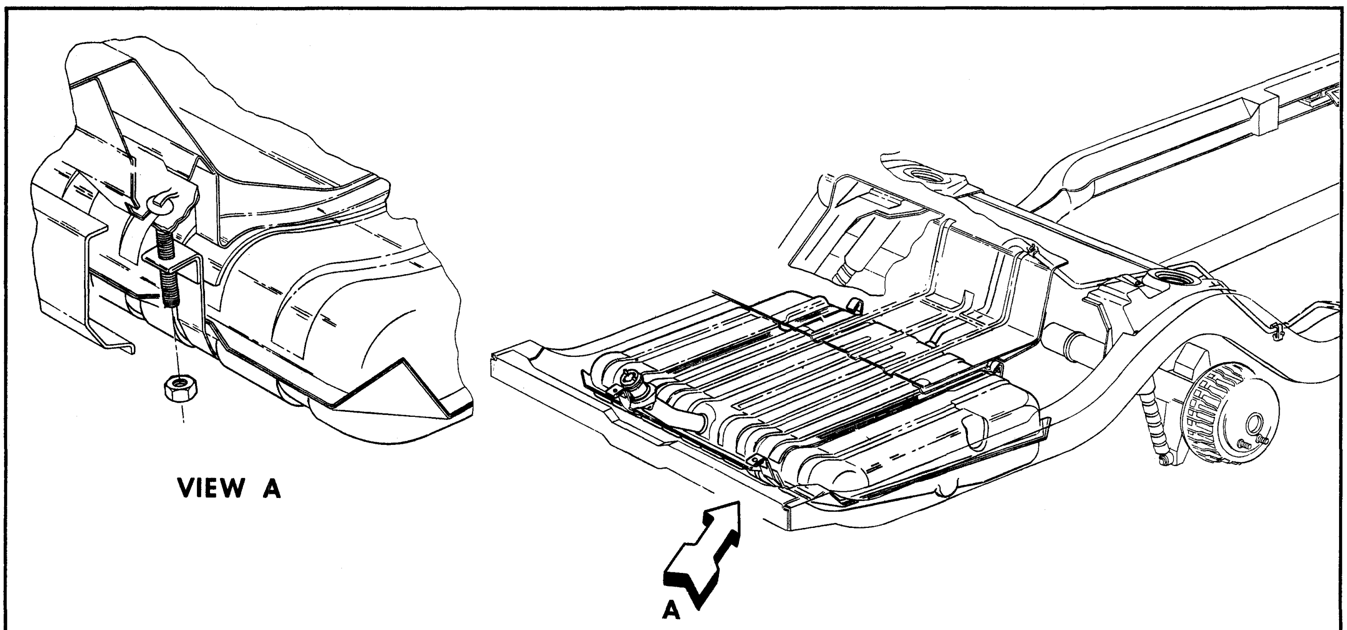



Fig. 8-1 Fuel Tank Mounting (Except Station Wagon)

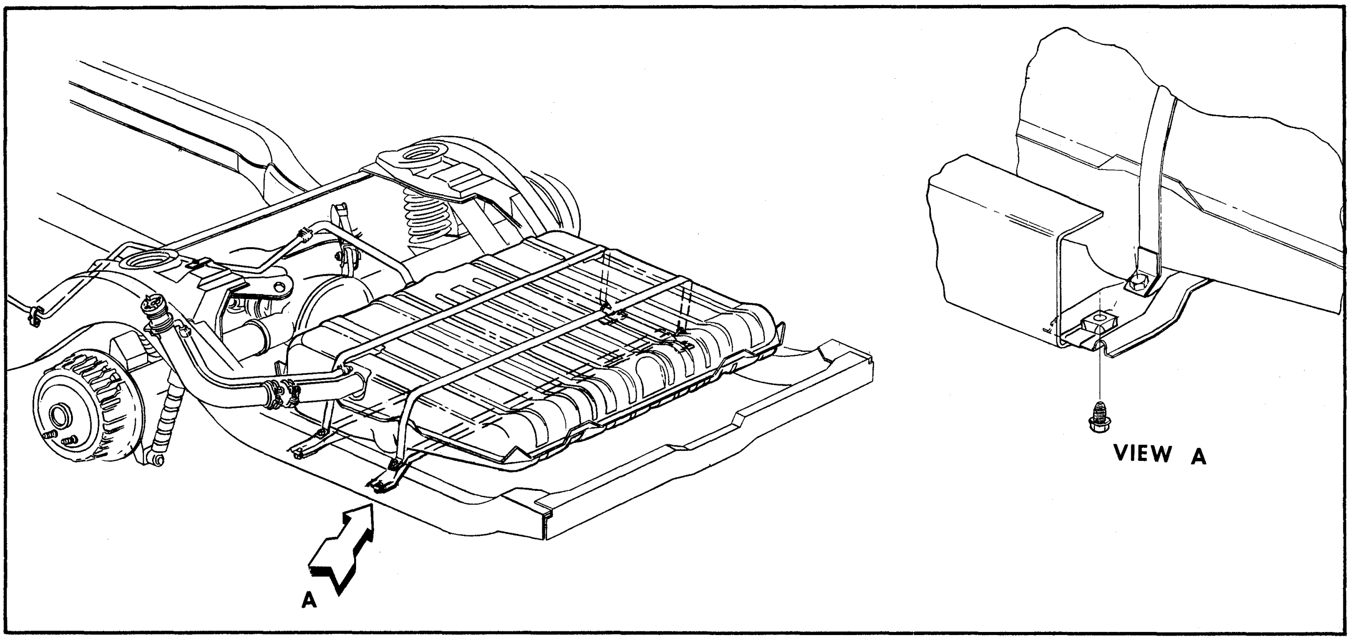



Fig. 8-2 Fuel Tank Mounting (Station Wagon)

*REMOVE AND REPLACE FUEL TANK—SEDANS, COUPES AND CONVERTIBLES*

1. Disconnect wire from tank gauge unit at the unit.

2. Raise car and support fuel tank.

3. Drain fuel tank as described on page 8-1.

4. Remove clamp connecting fuel line to tank.

5. Remove screws holding filler pipe bracket and seal to body.

6. Remove nuts securing support straps holding fuel tank to body.

7. Lower fuel tank from car.

To install, reverse above procedure.

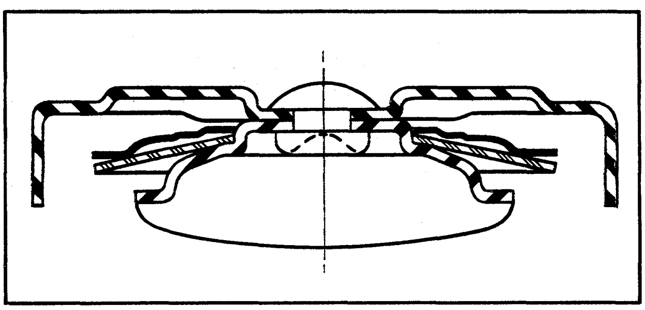


Fig. 8-3 Vent Cap

*REMOVE AND REPLACE FUEL TANK—STATION WAGON*

1. Disconnect wire from tank gauge unit at the unit.

2. Raise car and support fuel tank.

3. Drain fuel tank as described on page 8-1.

4. Remove clamp connecting fuel line to tank.

5. Remove clamp holding vent hose to filler pipe.

6. Disconnect vent hose from filler pipe.

7. Disconnect filler pipe rubber coupling by loosening clamp screws and sliding coupling toward tank.

8. Remove four nuts holding fuel tank to body and lower tank from car.

9. To install reverse removal procedure.

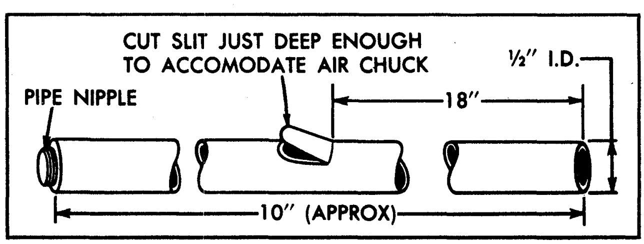



Fig. 8-4 Typical Drain Hose

## TROUBLE DIAGNOSIS

### *LEAKS*

Before removing fuel tank to correct a leak, a careful inspection of the tank should be made to determine as accurately as possible the source of the leak. So called "seam leaks" very often turn out to be loose screws at the fuel gauge tank unit. In this case the gasoline runs down on the flange of the seam and drips off at points along the seam giving the false indication of leaking seams.

### *NOISES*

Stones on top of the tank may be the cause and should be removed.

### *TANK UNIT*

Diagnosis for the fuel tank gauge unit appears in Section 11.

# EXHAUST SYSTEM

## DESCRIPTION

The major units of the exhaust system of the Six-Cylinder Engine (Fig. 8-1) are the exhaust pipe, muffler and tail pipe. The exhaust gases pass into the exhaust manifold. Here if the engine is cold a thermostatically controlled valve in the exhaust manifold partially blocks the passage of exhaust gases out of the manifold. Exhaust gases then heat the manifold. As the engine is thoroughly warmed up the exhaust gases are directed out through the exhaust pipe and muffler. The major units of the V-8 exhaust system (Fig. 8-2) are the exhaust pipe, muffler and tail pipe. The fuel burned in the combustion chamber of the engine passes into the exhaust manifolds of the engine. A heat riser pipe in the right hand manifold supplies heated air to the carburetor choke assembly. From the exhaust pipe the gases pass through the muffler and out the tail pipe.

## SERVICE PROCEDURES

### *SIX CYLINDER ENGINE (Fig. 8-5)*

#### *EXHAUST PIPE—REMOVE AND REPLACE*

1. Remove two nuts from exhaust pipe flange at manifold.

2. Sever pipe at front of muffler with cutting torch or saw and remove pipe.

3. Replace by clamping pipe at muffler and tightening exhaust pipe flange nuts to 22-30 lb. ft. torque.

#### *MUFFLER—REMOVE AND REPLACE*

1. Sever exhaust pipe at front of muffler with cutting torch or saw.

2. Remove U-clamp at rear of muffler.

3. Remove muffler.

4. Replace by clamping exhaust pipe at front of muffler and tightening rear U-clamp nuts to 15-20 lb. ft. torque.

#### *TAILPIPE—REMOVE AND REPLACE*

1. Remove U-clamp at rear of muffler.

2. Remove tailpipe hanger clamp.

3. Remove tailpipe.

4. Replace by reversing removal procedure. Tighten U-clamp nuts to 15-20 lb. ft. torque. Tighten hanger clamp bolt to 6-10 lb. ft. torque.

## V-8 ENGINE

### *SINGLE EXHAUST SYSTEM (Fig. 8-6)*

#### *EXHAUST PIPE—REMOVE AND REPLACE*

1. Remove two nuts from each exhaust pipe flange at exhaust manifold.

2. Remove U-clamp at front of muffler and remove exhaust pipe.

3. Replace by reversing removal procedure. Tighten exhaust pipe flange bolts to 25-35 lb. ft. torque. Tighten muffler front U-clamp nuts to 15-20 lb. ft. torque.

#### *MUFFLER—REMOVE AND REPLACE*

1. Remove U-clamps at front and rear of muffler.

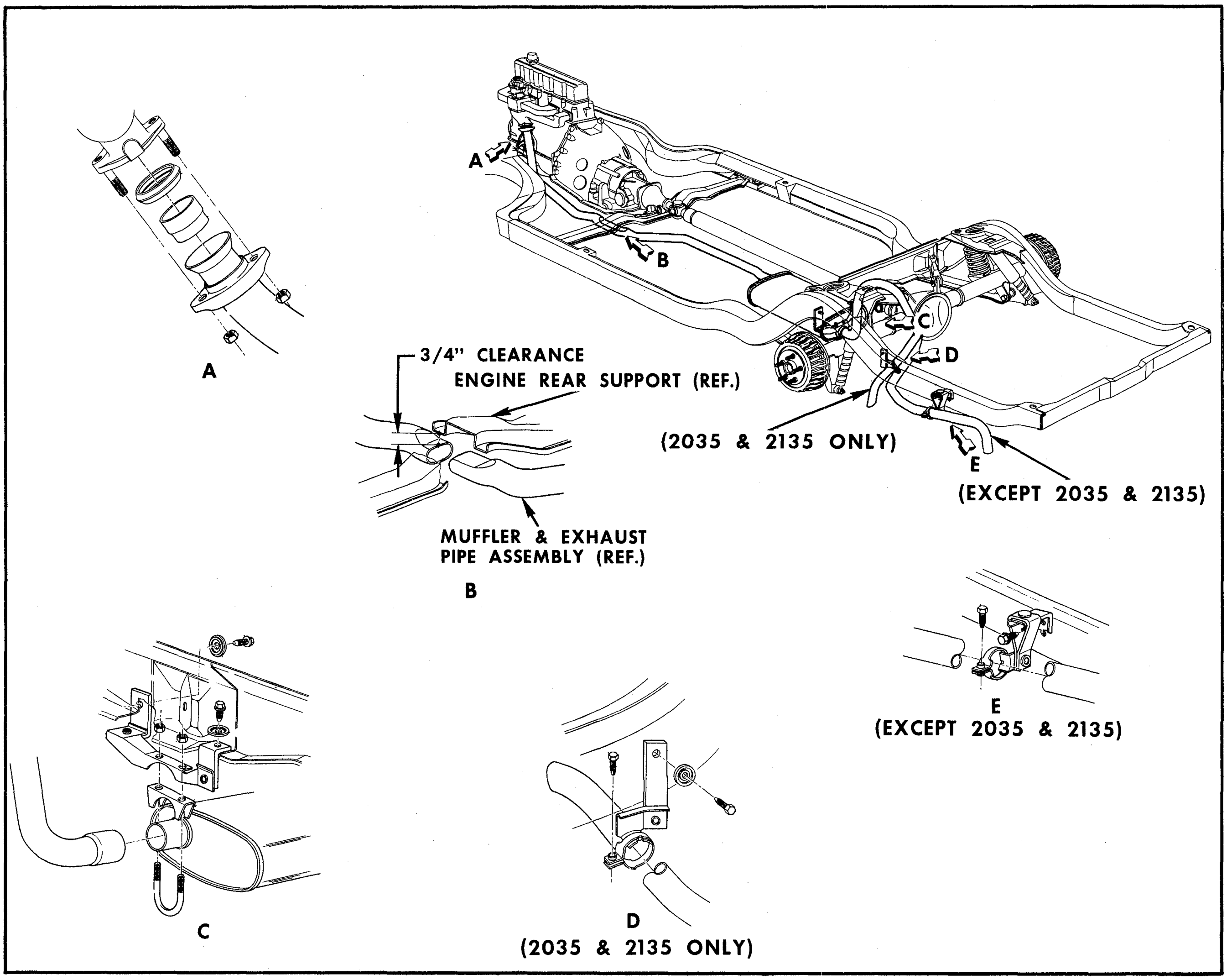



Fig. 8-5 Exhaust System - Six Cylinder Engine

2. Remove muffler.

3. Replace by reversing removal procedure. Tighten front and rear U-clamps to 15-20 lb. ft. torque.

### TAILPIPE—REMOVE AND REPLACE

1. Remove U-clamp at rear of muffler.

2. Remove tailpipe hanger clamp.

3. Remove tailpipe.

4. Replace by reversing removal procedure. Tighten U-clamp nuts to 15-20 lb. ft. torque. Tighten tailpipe hanger clamp bolt to 6-10 lb. ft. torque.

### DUAL EXHAUST SYSTEM (Fig. 8-7)

### EXHAUST PIPE—REMOVE AND REPLACE

1. Remove two nuts from exhaust pipe flange at manifold.

2. Remove U-clamp at front of muffler and remove exhaust pipe.

3. Replace by reversing removal procedure. Tighten exhaust pipe flange bolts to 25-35 lb. ft. torque. Tighten muffler front U-clamp nuts to 15-20 lb. ft. torque.

### MUFFLER—REMOVE AND REPLACE

1. Remove U-clamps at front and rear of muffler.

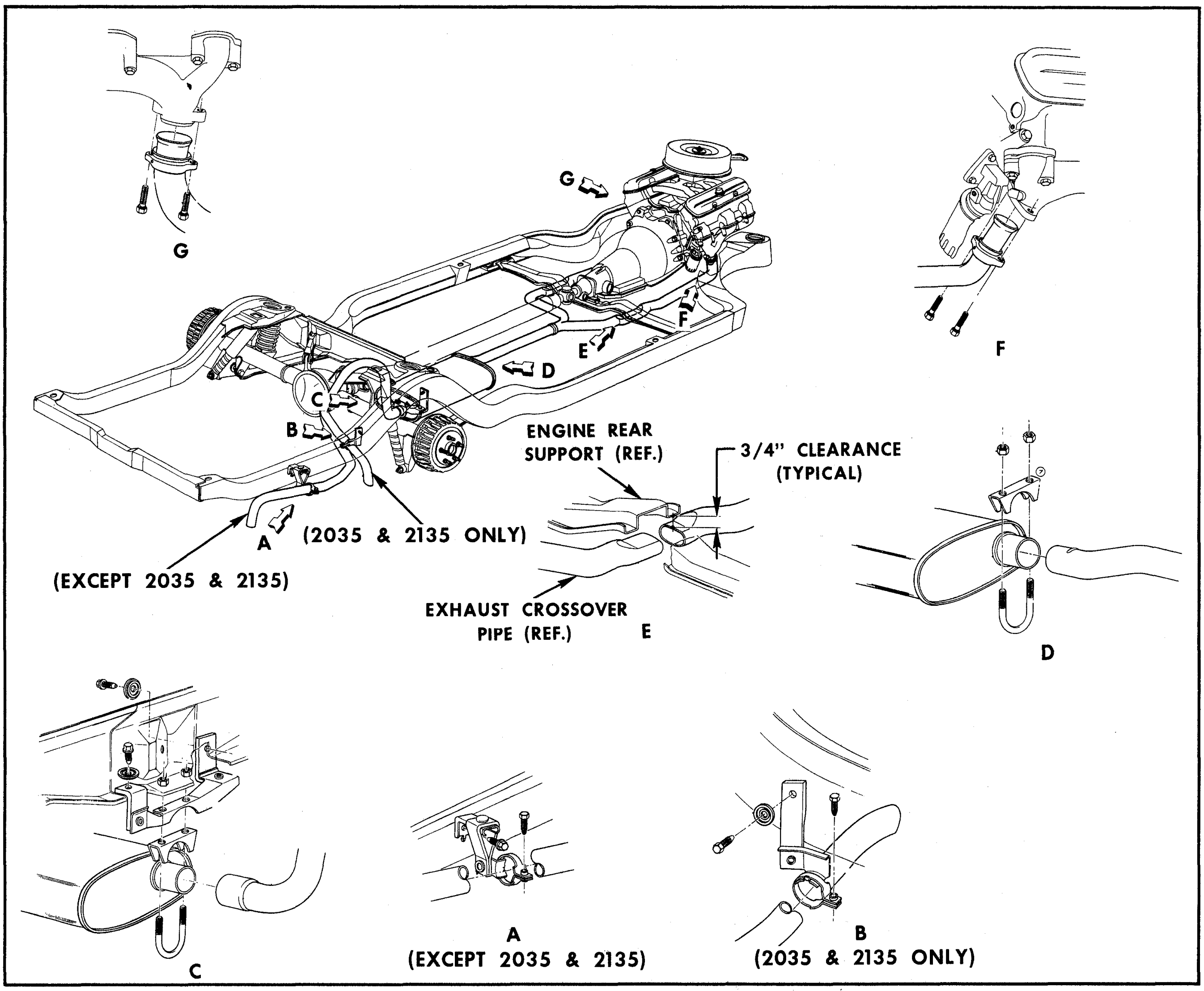



Fig. 8-6 Exhaust System - Eight Cylinder Engine, Single Exhaust

2. Remove muffler.

3. Replace by reversing removal procedure. Tighten front and rear U-clamp bolts to 15-20 lb. ft. torque.

#### TAILPIPE—REMOVE AND REPLACE

1. Remove U-clamp at rear of muffler.

2. Remove tailpipe hanger clamp.

3. Remove tailpipe.

4. Replace by reversing removal procedure. Tighten U-clamp nuts to 15-20 lb. ft. torque. Tighten tailpipe hanger clamp bolt to 6-10 lb. ft. torque.

## SPECIFICATIONS

Fuel Tank Capacity . . . . . . . . . . . . . 21.5 gal.
Six Cylinder Engine
  Exhaust Pipe Diameter . . . . . . . . . . . . . 2"
  Tail Pipe Diameter . . . . . . . . . . . . . . . 2"
V-8 Engine
  Exhaust Pipe Diameter . . . . . . . . . . . 2 1/4"
  Tailpipe Diameter . . . . . . . . . . . . . . . . . 2"

## TORQUE SPECIFICATIONS

(Torque in ft. lbs. unless otherwise specified)

APPLICATION TORQUE

FUEL TANK MOUNTING

Nut - Fuel Tank Strap to Support
  (Station Wagon) . . . . . . . . . . . . .70-100 lb. in.

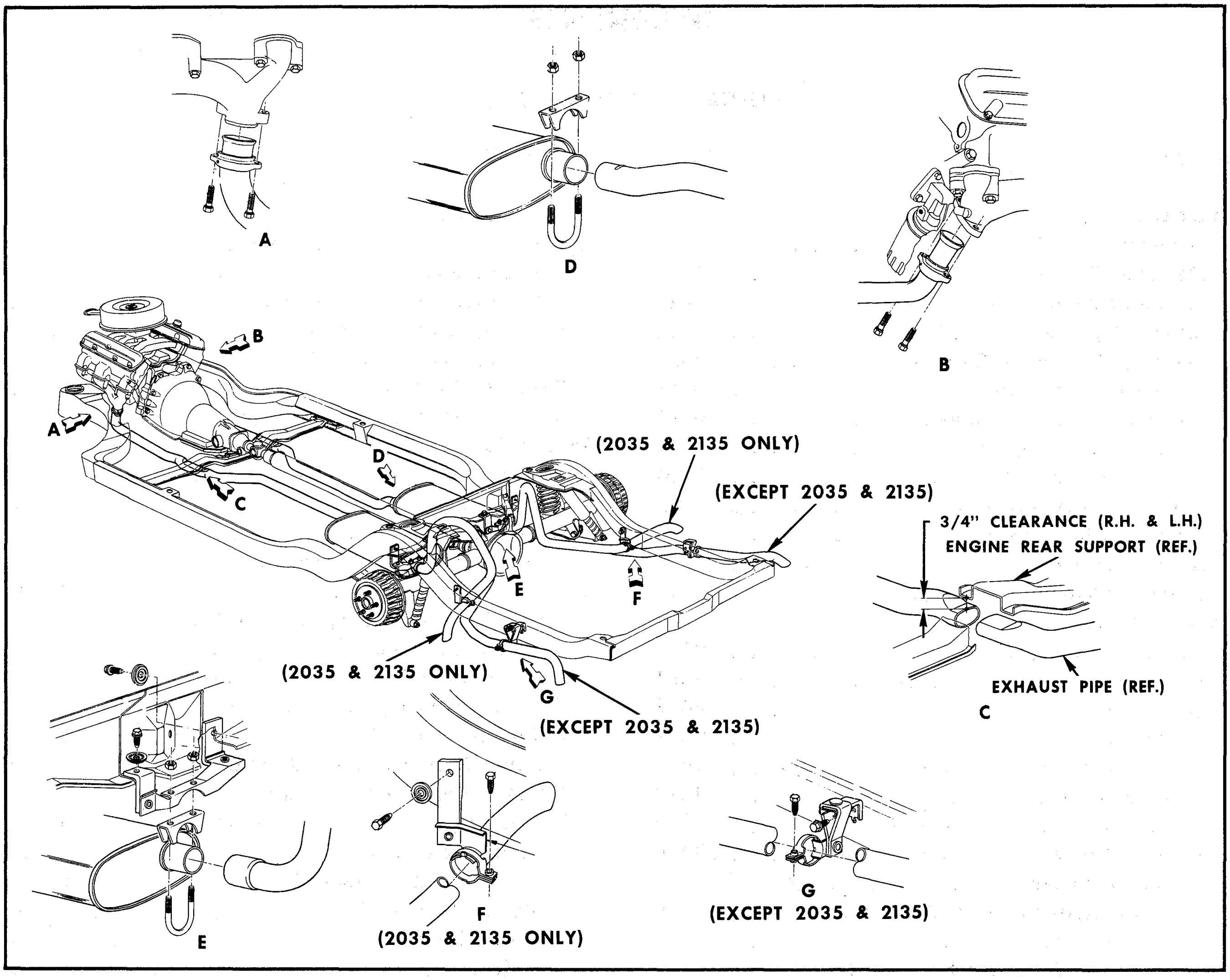



Fig. 8-7 Exhaust System - Eight Cylinder Engine, Dual Exhaust

| APPLICATION | TORQUE |
|---|---|
| Nut - Fuel Tank Strap to Underbody (Exc. Station Wagon) | 70-100 lb. in. |
| MUFFLER - EXHAUST PIPE - TAILPIPE | |
| Nut - Exhaust Pipe to Muffler U-Bolt | 15-20 |

| APPLICATION | TORQUE |
|---|---|
| Nut - Tailpipe to Muffler U-Bolt | 15-20 |
| Screw - Muffler Tailpipe Hanger to Frame | 10-15 |
| Screw - Tailpipe Hanger to Frame | 10-15 |
| Screw - Tailpipe Clamp to Hanger Assy. | 6-10 |
| Nut - Exhaust Pipe Manifold Stud (6 Cyl. Eng. | 22-30 |

# STEERING

## CONTENTS OF THIS SECTION



## STANDARD STEERING GEAR

### GENERAL DESCRIPTION

The standard steering gear (Fig. 9-1) is of the recirculating ball nut type having a gear ratio of 24 to 1 with an overall ratio of 28.32 to 1. The steering shaft, worm shaft and worm nut are all in line making a compact and easily serviced gear.

The steering shaft and worm shaft are separated with a flexible coupling which permits removal of the gear assembly or steering shaft (and column) independent of each other.

The mechanical element of this steering gear is a low-friction, high-efficiency recirculating ball system in which steel balls act as a rolling thread between the steering worm and nut. The nut is one piece and is geared to the sector of the pitman shaft. Lash between the pitman shaft and rack piston nut is maintained by an adjusting screw which is retained in the end of the pitman shaft gear (Fig. 9-2).

The ball nut, mounted on the worm, is driven through steel balls which circulate in helical grooves in both the worm and nut. Ball return guides, attached to the nut, serve to recirculate the two sets of twenty-five balls each in the grooves.

As the steering wheel is turned to the right, the nut moves upward. When the wheel is turned to the left the nut moves downward.

The teeth on the sector, which are forged as part of the pitman shaft, and the ball nut are so designed

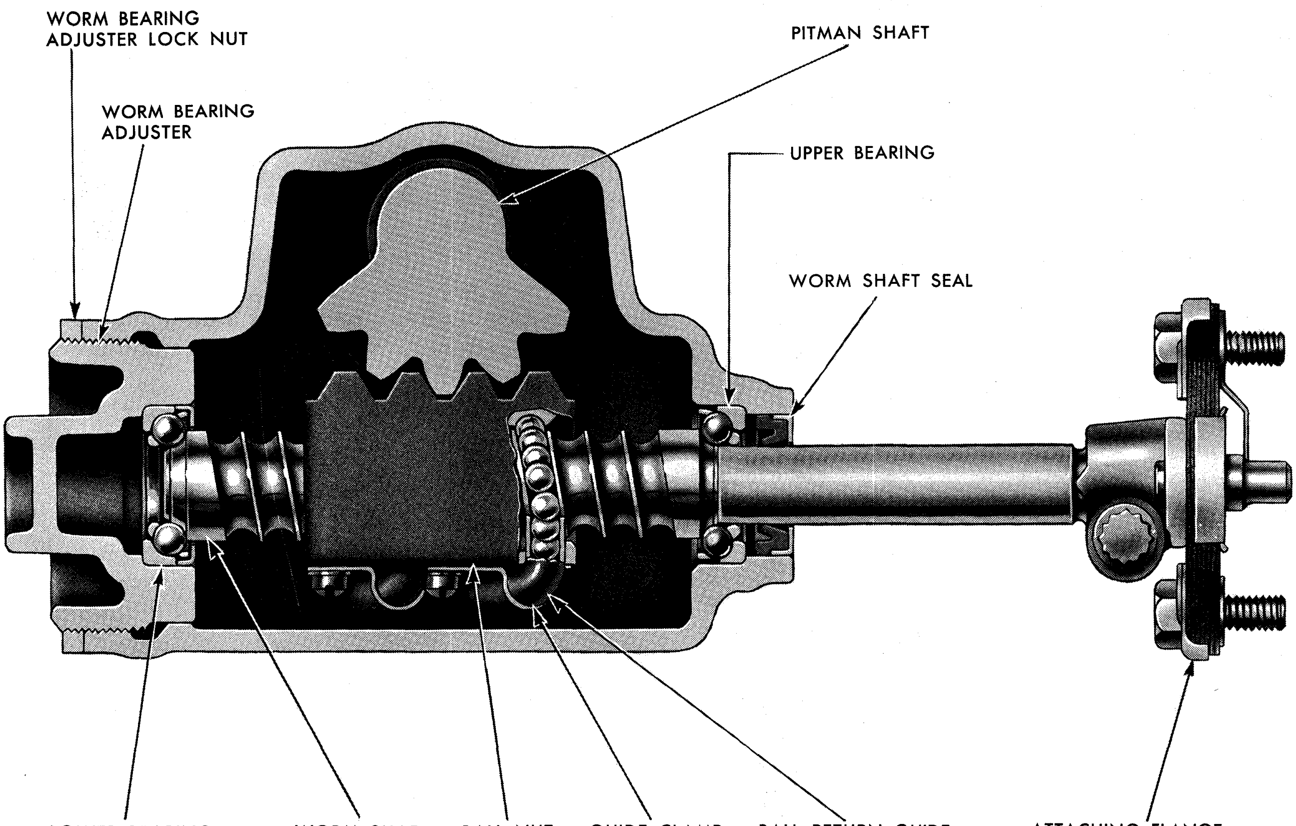



Fig. 9-1 Cross Section of Standard Steering Gear

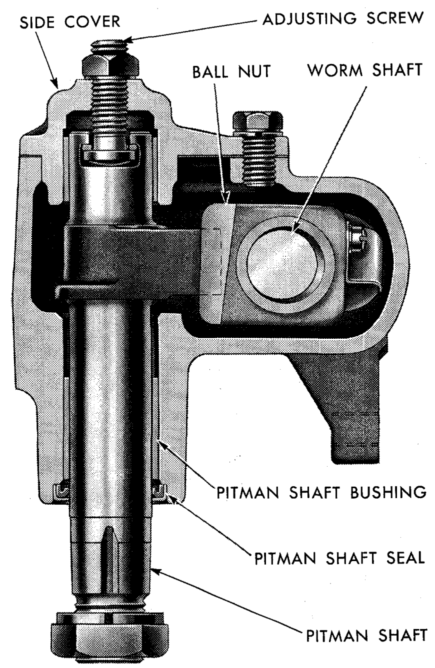



Fig. 9-2 Cross Section Through Pitman Shaft

that a tighter fit exists between the two when the front wheels are straight ahead. Proper engagement between the sector and the ball nut is obtained by an adjusting screw which moves the pitman shaft endwise permitting desired engagement of the tapered teeth of the ball nut and sector gear. The worm bearing adjuster can be turned to provide proper preloading of the upper and lower bearings.

## PERIODIC SERVICE

Periodic service consists of periodical lubrication as outlined in GENERAL LUBRICATION Section. The addition of the lubricant is to be made by removing the center side cover bolt (Fig. 9-3).

## ADJUSTMENTS ON CAR

Correct adjustment of the steering gear is extremely important. Before any adjustments are made to the steering gear in an attempt to correct such conditions as shimmy, hard or loose steering and road shocks, careful check should be made to determine that front end alignment, shock absorbers,

wheel balance and tire pressure are correctly adjusted and/or operating satisfactorily.

There are two adjustments on the recirculating ball type steering gear:

1. Worm bearing preload adjustment.

2. Sector and ball nut and backlash adjustment.

*CAUTION: It is very important when adjusting the steering gear that the adjustments be made in the above sequence. Failure to do so will result in damage to the steering gear.*

### *ADJUST WORM BEARING PRELOAD*

1. Disconnect steering connecting rod from pitman arm (Fig. 9-4).

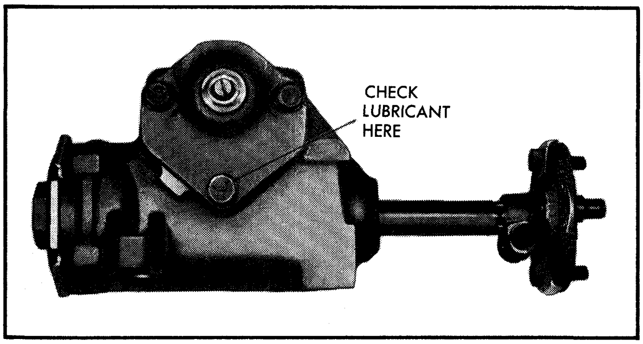



Fig. 9-3 Addition of Lubricant

2. Loosen pitman shaft adjusting screw lock nut and back off adjusting screw a few turns (Fig. 9-5).

3. Remove horn button or horn ring and steering wheel.

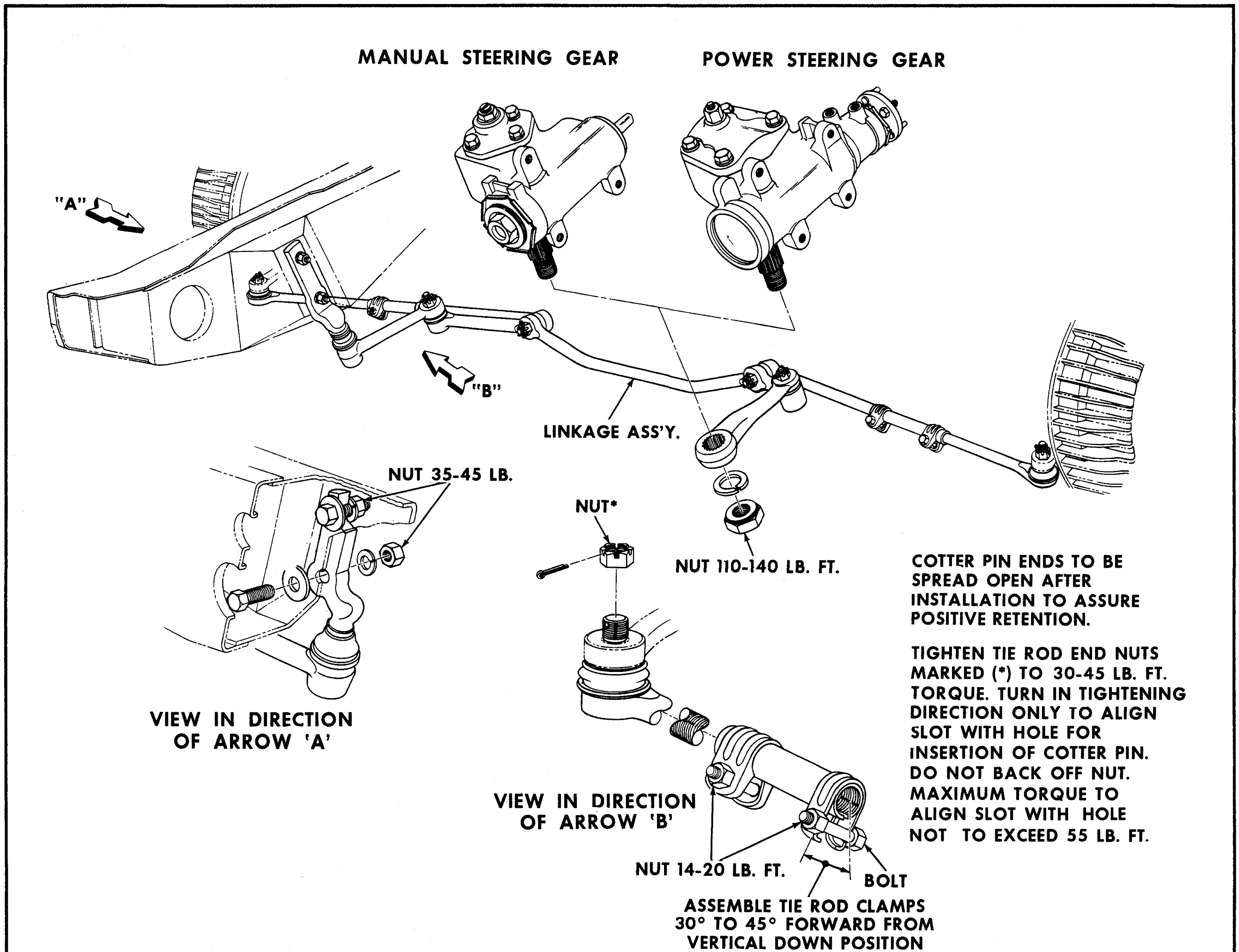



Fig. 9-4 Steering Linkage

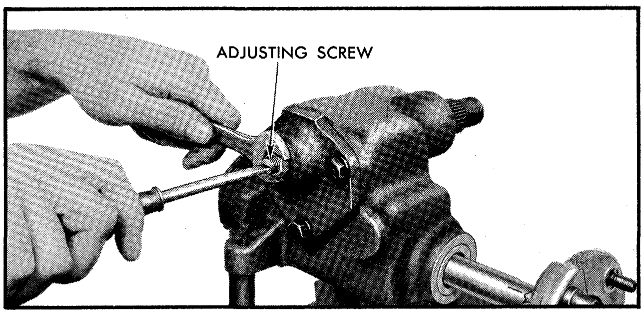



Fig. 9-5 Adjusting Pitman and Ball Nut Backlash

4. With lb. in. torque wrench attached to a 5/8"-12 point socket, measure and record at least 30° off center (Fig. 9-6).

*NOTE: Do not use a torque wrench having maximum torque reading of more than 100 pounds inch. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one half of this total as the average torque.*

5. Torque required should be between 5-9 lb. in. To correct, loosen worm bearing adjuster lock nut with brass drift and turn adjuster to bring torque within limits.

6. Retighten lock nut when adjustment is correct and recheck as in step 4 above.

### *ADJUST SECTOR AND BALL NUT BACKLASH*

1. When worm bearing preload has been adjusted correctly, pitman shaft adjusting screw should be turned clockwise until a pull equal to the worm bearing preload plus 4-9 lb. in. is required to turn the wheel through the center.

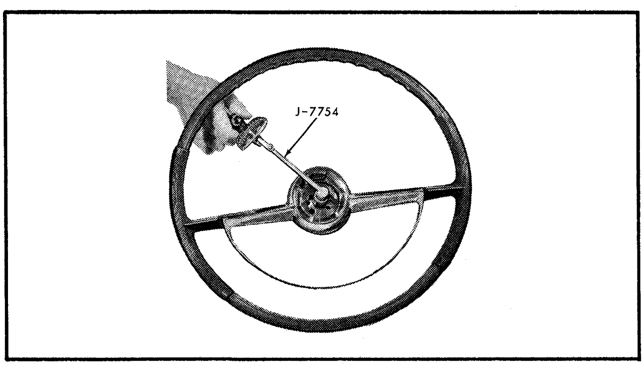



Fig. 9-6 Checking Steering Gear Adjustment

Total thrust bearing adjustment, pitman shaft adjustment, and drag to exceed 14 lb. in.

2. Tighten pitman shaft adjusting screw locknut, and recheck adjustment.

3. Reassemble steering connecting rod to pitman arm. Set spokes of steering wheel in straight ahead position (mark on steering shaft up, Fig. 9-6). If road wheels are not straight ahead, adjust steering tie rods.

## MINOR REPAIRS
## STANDARD AND DELUXE STEERING WHEEL

REMOVE AND REPLACE (Fig. 9-8)

1. Lift to remove ornament.

2. Remove nut and washer from shaft.

3. Remove spacer bushing.

4. Remove horn ring (deluxe wheel) or receiver cup (standard wheel).

5. Remove pivot ring (deluxe wheel) and belleville spring.

6. Remove contact assembly.

7. Remove steering wheel using puller J-3044-01.

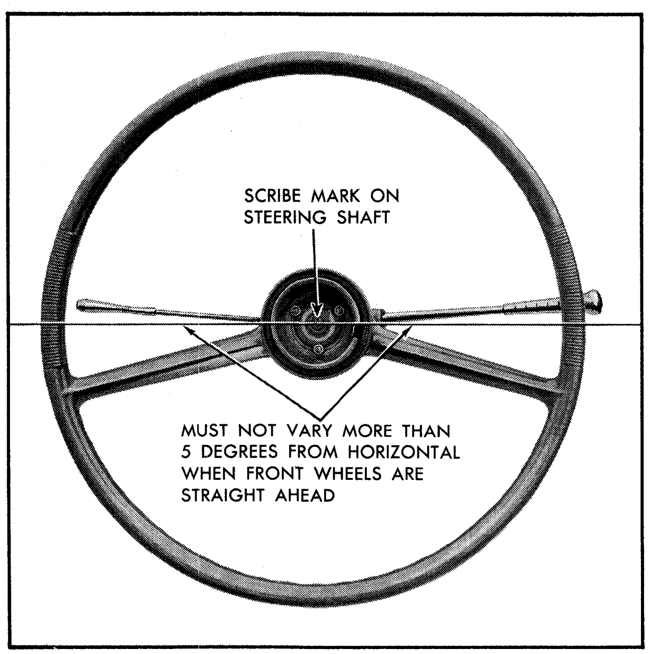



Fig. 9-7 Locating Steering Wheel Position

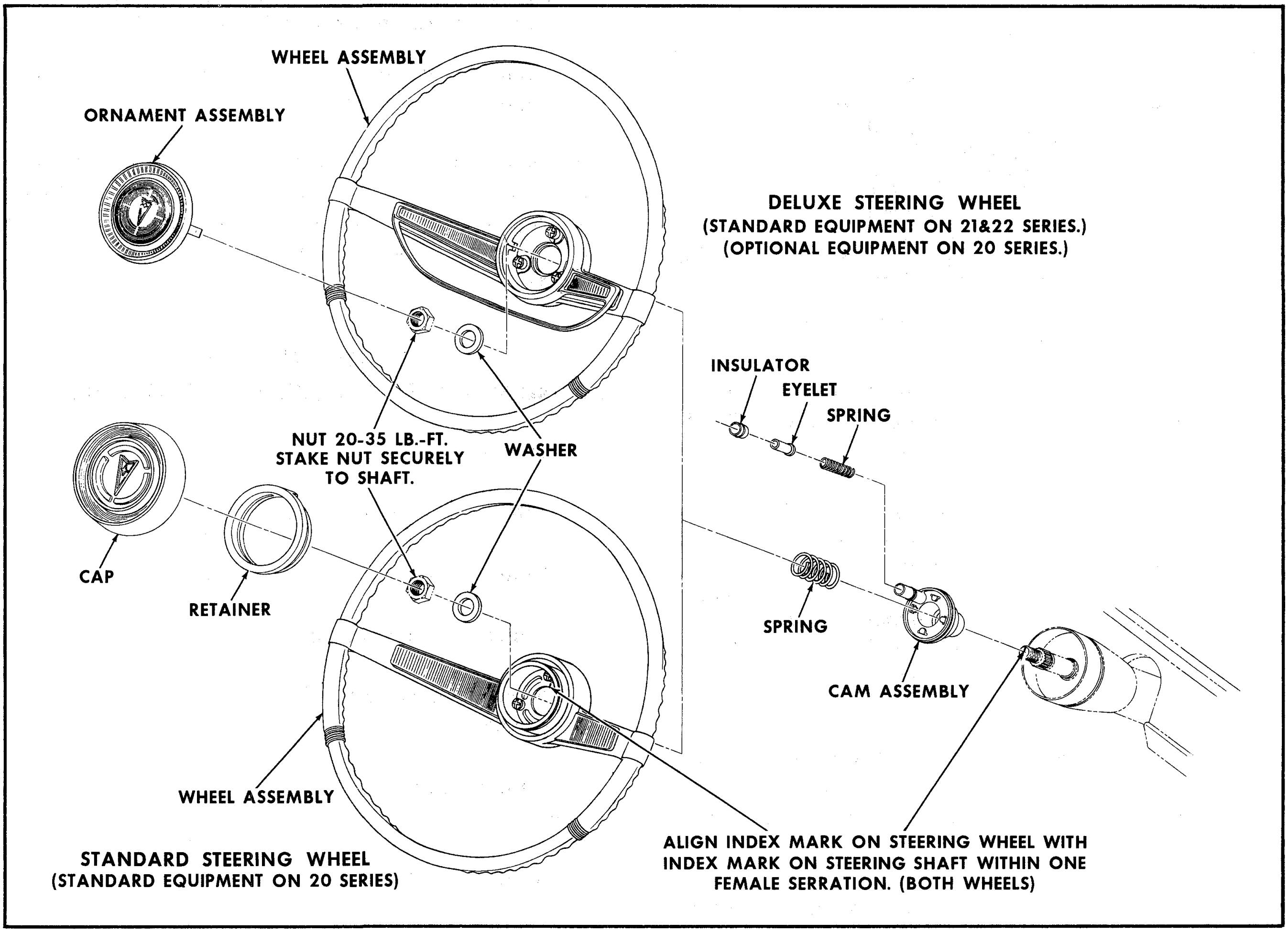



Fig. 9-8 Steering Wheel and Horn Button - Exploded View

8. To replace, reverse the above procedure, making sure steering wheel is in straight ahead position (Fig. 9-7). Tighten steering wheel nut to 20-35 lb. ft. torque and stake.

## STEERING COLUMN OVERHAUL

*NOTE: Procedure applies specifically to synchromesh (Fig. 9-9). May be used for automatic by referring to Fig. 9-10 and eliminating steps pertaining to synchromesh column.*

### *REMOVE*

1. Disconnect first and reverse shifter rod from lower lever and second and third shifter rod from upper lever at steering column.

2. Remove two steering shaft to steering gear retaining bolts.

3. Remove steering wheel as outlined under STANDARD STEERING WHEEL REMOVE OR DELUXE STEERING WHEEL - REMOVE.

4. Remove four screws securing toe pan to floor pan.

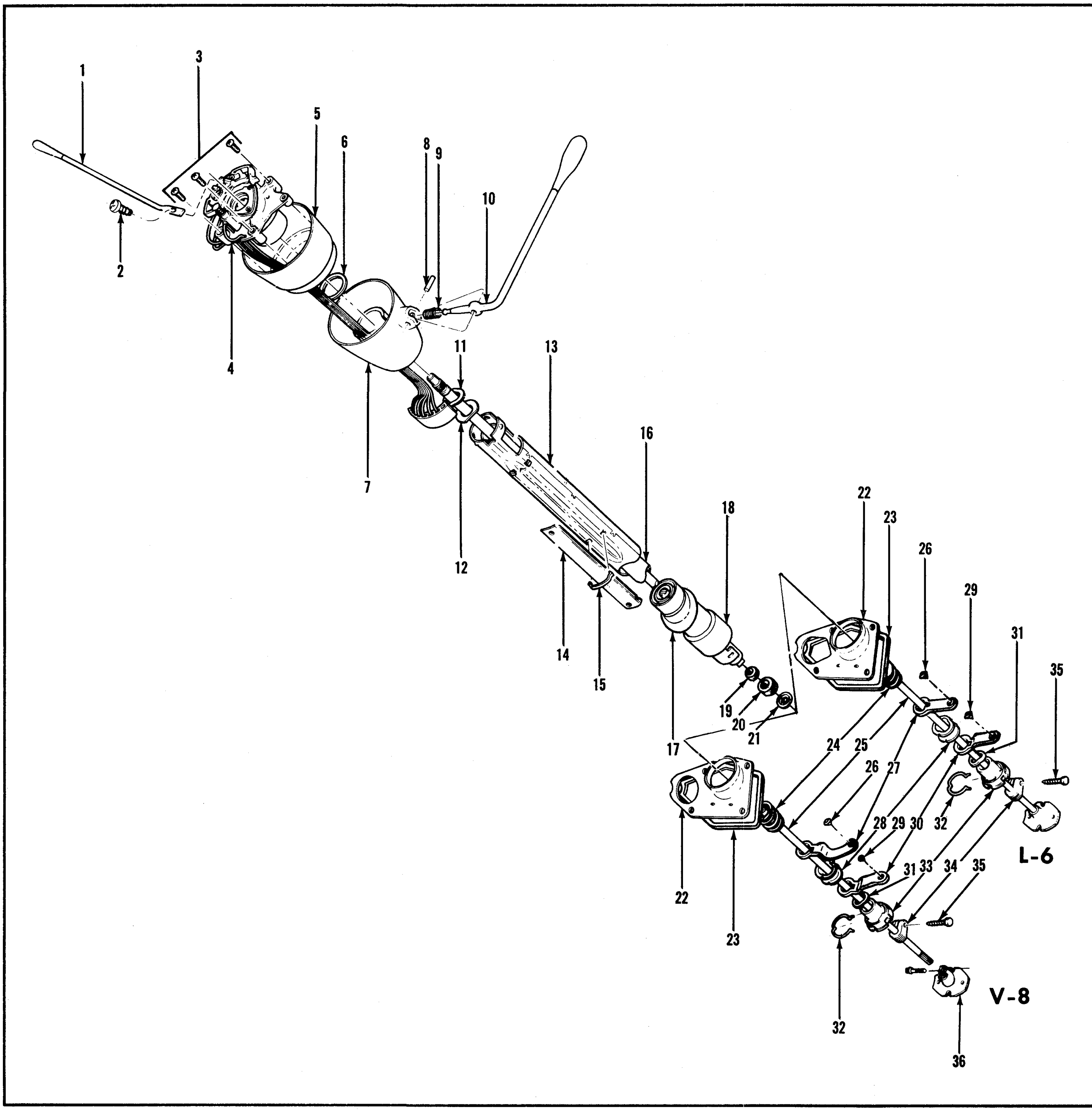
5. Disengage clutch rod at both ends by removing clips and washers.

*NOTE: It is not necessary to loosen clutch rod clevis adjusting nuts to disconnect clutch rod from clutch pedal.*

6. Push clutch rod insulator and clutch rod through hole in toe pan.

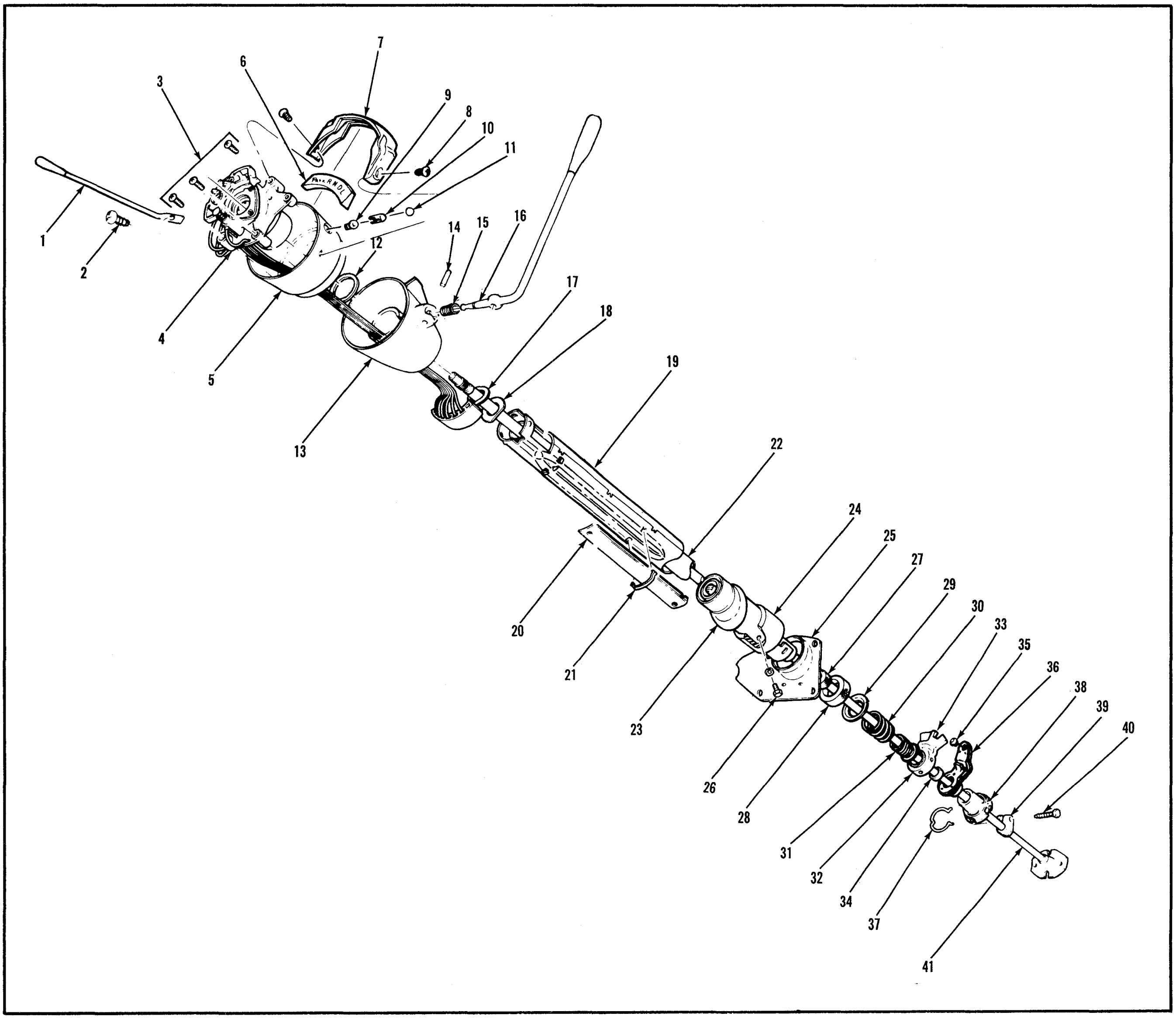
7. Lift toe pan over end of clutch rod and remove.

8. Disconnect wiring connectors from back-up light switch and directional signal and horn wire connector.




1. Lever Assy. Directional Signal
2. Retaining Screw, Directional Signal Lever #8-32 x 1/2"
3. Retaining Screws, Directional Signal Control Assy.
4. Control Assy., Directional Signal
5. Housing Assy., Directional Signal
6. Washer
7. Shift Bowl
8. Ping - Shift Lever
9. Spring - Shift Lever
10. Shift Lever
11. Wave Washer
12. Retainer Washer
13. Jacket, Steering Column
14. Cover, Wiring
15. Retainer, Wiring Cover
16. Shift Tube
17. Grommet
18. Sleeve, Steering Column Jacket
19. Seal - Steering Shaft
20. Seal - Steering Column Gearshift Tube
21. Seat
22. Cover, Steering Column
23. Seal
24. Spring
25. Shaft, Steering Gear Upper
26. Bushing, Shift Lever
27. Shift Lever, Second and Third
28. Spacer, Shift Tube
29. Bushing, Shift Lever
30. Shift Lever, First and Reverse
31. Washer, Spring
32. Retainer, Lower
33. Adapter Assy.
34. Clamp, Steering Shaft
35. Screw, Steering Shaft Clamp #14-10 x 1.00
36. Flange Assy.

Fig. 9-9 Steering Column for Synchromesh Transmission—Exploded View




1. Lever Assy. Directional Signal
2. Retaining Screw, Directional Signal Lever #8-32 x 1/2"
3. Retaining Screws, Directional Signal Control Assy. (3)
4. Control Assy., Directional Signal
5. Housing Assy., Directional Signal
6. Dial, Gearshift Indicator
7. Retainer, Gearshift Indicator Dial
8. Screw #8-32 x 1/4" (2)
9. Lamp
10. Cap
11. Filter
12. Washer
13. Shift Bowl
14. Pin, Shift Lever
15. Spring, Shift Lever
16. Lever Assy. Gearshift Control Upper
17. Wave Washer
18. Retainer Washer
19. Jacket, Steering Column
20. Cover Steering Column Wiring
21. Retainer, Wiring Cover
22. Shift Tube
23. Grommet
24. Sleeve, Steering Column Jacket
25. Cover, Steering Column
26. Screw, Hex 1/4-28 x 3/8 (3)
27. Seal, Shift
28. Seal
29. Seat, Spring
30. Spring
31. Spring
32. Seat, Spring
33. Control Selector
34. Sleeve
35. Bushing
36. Lever
37. Retainer, Lower
38. Adapter Assy.
39. Clamp, Steering Shaft
40. Screw, Steering Shaft Clamp #14-10 x 1.00
41. Shaft and Flange, Steering Gear Upper

Fig. 9-10 Steering Column for Automatic Transmission—Exploded View

9. Remove two steering column cover plates to instrument panel attaching screws and remove cover plate.

10. Remove two steering column bracket to instrument panel attaching screws and washers and remove bracket and insulator.

11. Withdraw entire steering column and shaft assembly.

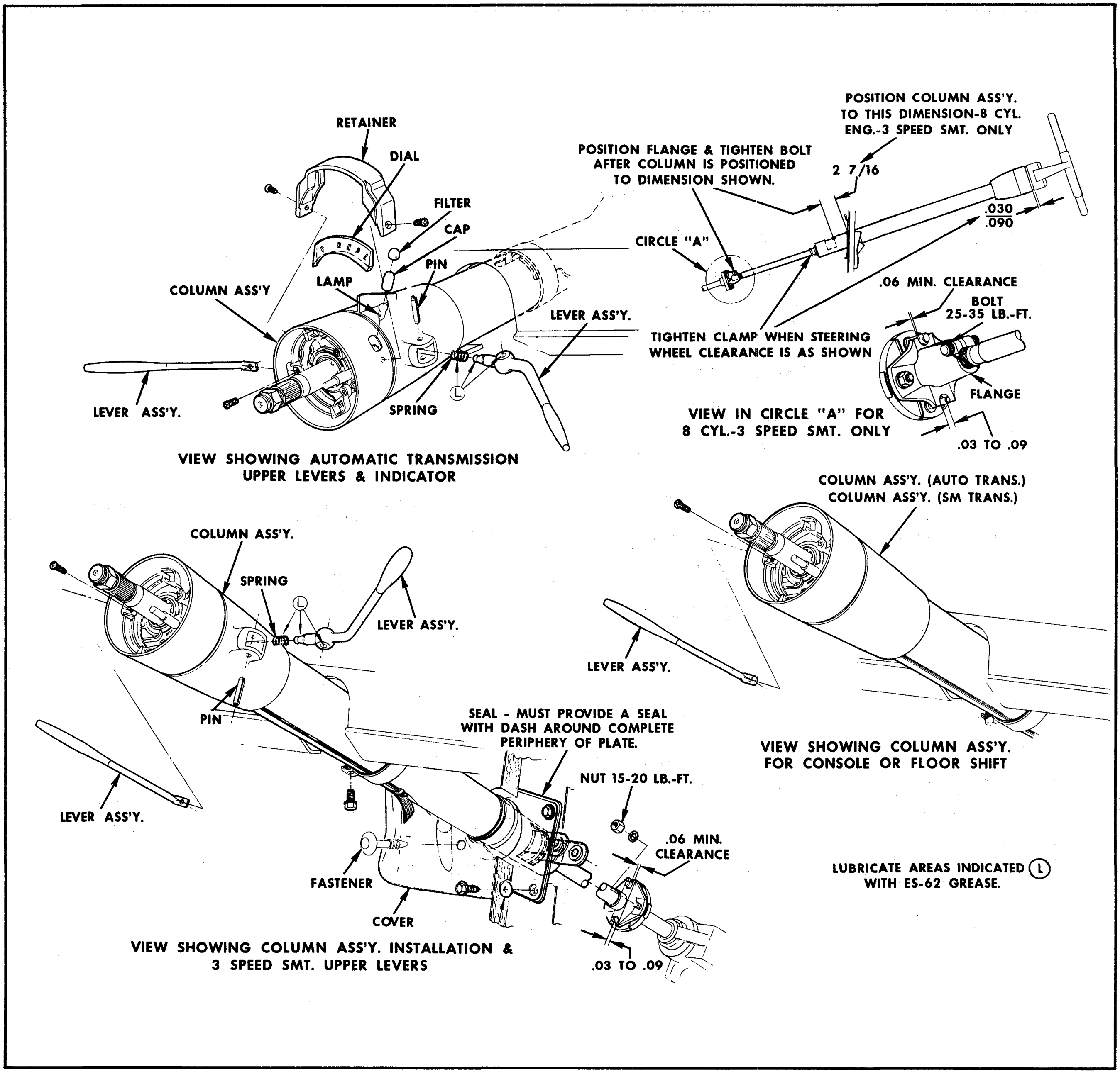



Fig. 9-11 Steering Column and Upper Levers

## STEERING COLUMN—DISASSEMBLE

1. Remove retainer from lower end of steering column housing.

2. Remove steering gear shaft lower bearing assembly from steering column assembly.

3. Remove back-up lamp switch from steering column housing.

4. Remove directional signal lever by removing retaining screws.

5. Remove gearshift lever and spring by removing pivot pin.

6. Remove clip and wire cover plate.

7. Remove three retaining screws on upper bearing and directional signal switch. Lift bearing and switch assembly up out of upper bowl.

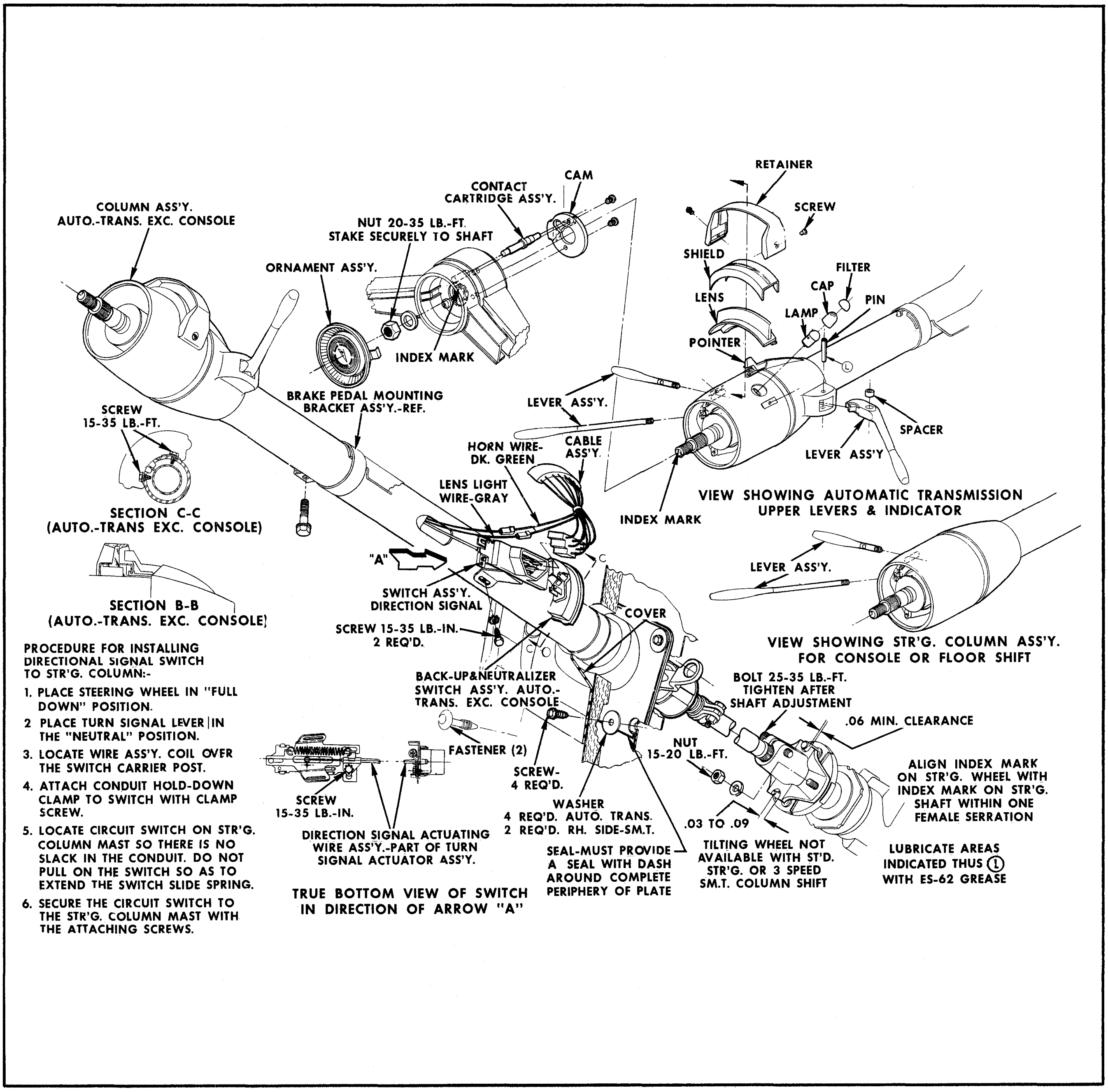



Fig. 9-12 Tilt Steering Wheel Column

8. Rotate directional signal housing counterclockwise and remove.

9. Remove shift bowl by sliding off.

10. Rotate shift tube counterclockwise and remove from upper end of steering column housing. Remove felts from inside and outside of shift tube.

11. Remove shift levers, plastic spacer and wave washer from lower end of column housing.

STEERING COLUMN - ASSEMBLE (Fig. 9-11)

1. Replace felt spacer on shift tube.

2. Insert shift tube into column housing. (Caution should be taken so as not to damage felt spacer on shift tube.) Index lug on shift tube with slot in column housing.

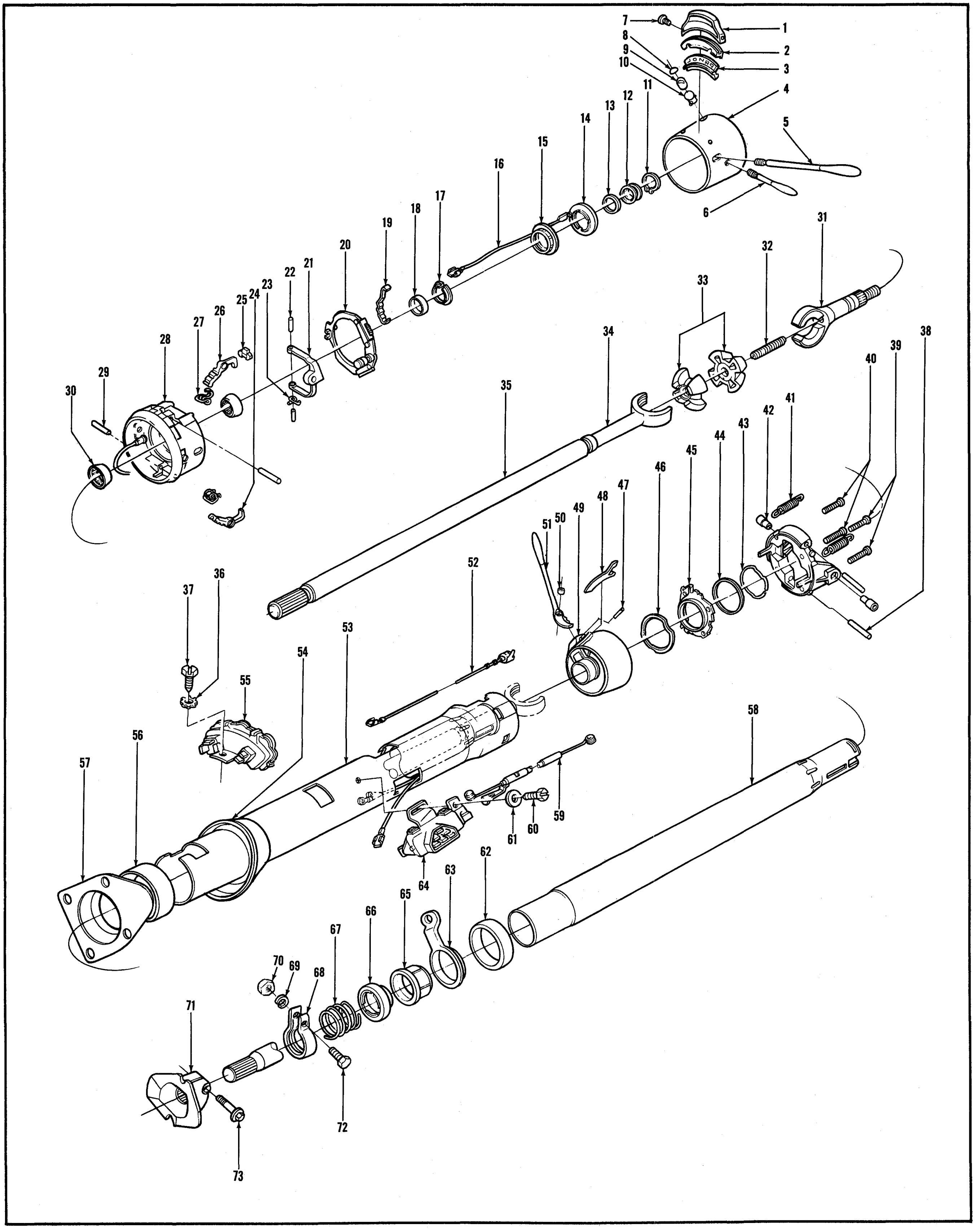


Fig. 9-13 Steering Column with Tilting Wheel—Exploded View

1. Retainer, Gearshift Indicator
2. Shield, Gearshift Indicator Lens
3. Lens, Gearshift Indicator
4. Cover, Directional Signal Control
5. Lever, Directional Signal Control
6. Lever, Tilting Wheel Release
7. Screw
8. Filter Shift Indicator Lens Lamp
9. Cap, Shift Indicator Lens Lamp
10. Bulb, Indicator
11. Ring, Bearing Spring Retaining
12. Capsule, Steering Column Preload
13. Washer, Preload Capsule
14. Contact, Horn Button
15. Insulator, Horn Button Contact
16. Cable, Horn Button Contact
17. Seat, Upper Bearing Spring
18. Race, Upper Bearing Inner
19. Spring Detent
20. Yoke, Actuator
21. Actuator, Shoe Release
22. Pin, Actuator (2)
23. Spring, Actuator
24. Shoe, Lock
25. Stop, Shoe Lock
26. Shoe, Lock
27. Spring, Lock Shoe (2)
28. Housing, Actuator
29. Pin, Shoe Dowel (2)
30. Bearing, Steering Shaft Upper (2)
31. Shaft, Steering Column Upper
32. Spring, Steering Shaft Joint Preload
33. Sphere, Steering Shaft Centering
34. Yoke, Steering Shaft Coupling
35. Shaft, Steering Column Lower
36. Lockwasher
37. Screw, Switch to Jacket
38. Pin, Support (2)
39. Screw (2)
40. Screw, Support (2)
41. Spring, Tilt Wheel (2)
42. Pin, Pivot (2)
43. Ring, Shift Tube Retainer
44. Washer, Bowl Thrust
45. Plate, Steering Column Lock
46. Washer, Steering Column Wave
47. Pin, Gearshift Lever Fulcrum
48. Pointer, Transmission Indicator
49. Bowl, Gearshift Lever
50. Spacer, Gearshift Lever
51. Lever, Gearshift Control Upper
52. Socket Assy. Transmission Indicator
53. Jacket, Steering Column
54. Grommet, Steering Column
55. Switch, Neutralizer and Back-Up Lite
56. Sleeve, Steering Column Jacket
57. Cover, Steering Column to Toe Pan
58. Tube, Gearshift
59. Wire Assy. Directional Switch Actuating
60. Screw
61. Washer
62. Seal, Steering Column Lower
63. Lever, Gearshift Lower Shift
64. Switch Assy., Directional Signal
65. Adapter, Steering Column Lower Shift Tube
66. Bearing Assy. Steering Shaft
67. Spring, Steering Column Bearing
68. Clamp, Steering Shaft
69. Lockwasher, Steering Shaft Clamp
70. Nut, Steering Shaft Clamp
71. Flange, Shaft Upper
72. Bolt,Steering Shaft Clamp
73. Bolt, Steering Column Shaft Upper Flange to Shaft

Fig. 9-13 Steering Column with Tilting Wheel—Exploded View

3. Draw shift tube back and insert shift levers, plastic spacer and wave washer in position in lower end of column housing. Push shift tube into place against spring pressure. Rotate clockwise to lock in position.

4. Install washer and wave washer in upper end of column housing.

5. Insert wire loom on upper bearing and directional signal switch through directional signal housing and shift bowl.

6. Position shift bowl on column housing.

7. Install washer on upper end of shift tube.

8. Place upper bowl in position and rotate clockwise to lock in position.

9. Secure upper bearing and directional signal switch with three screws. Torque screws to 20-35 lb. in.

10. Install wire cover.

11. Place lower bearing assembly and felt on steering gear shaft.

12. Start steering shaft into shift tube and push felt into lower opening of shift tube.

13. Place lower bearing in position and install retainer.

14. Replace directional signal selector lever.

15. Replace transmission selector lever.

16. Replace back-up lamp switch.

### *TILT WHEEL STEERING COLUMN—(Figs. 9-12 and 9-13)*

DISASSEMBLE

1. Remove turn signal switch from mast jacket by removing two attaching screws and disconnecting turn signal switch control cable.

2. Remove neutral safety and back up lamp switch assembly from mast jacket.

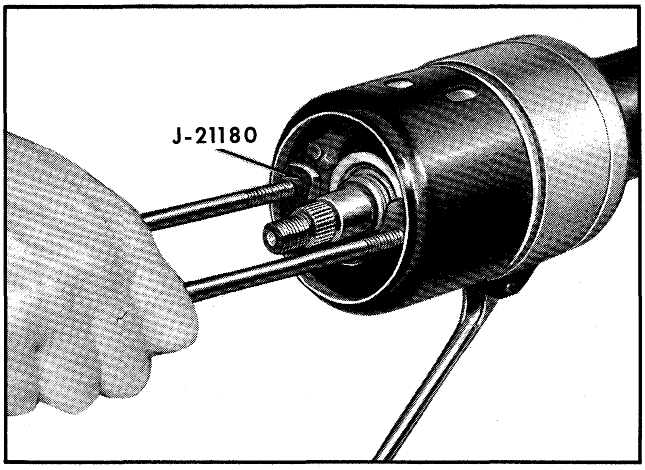



Fig. 9-14 Removing Cover

3. Remove horn button lens by carefully prying up on bezel.

4. Remove three spacer bushing screws, then remove spacer bushing.

5. Remove receiver cup, Belleville spring and horn contact.

6. Remove steering wheel nut, then remove steering wheel using puller J-3044.

7. Remove turn signal and tilt levers.

8. Remove automatic transmission indicator assembly and bulb.

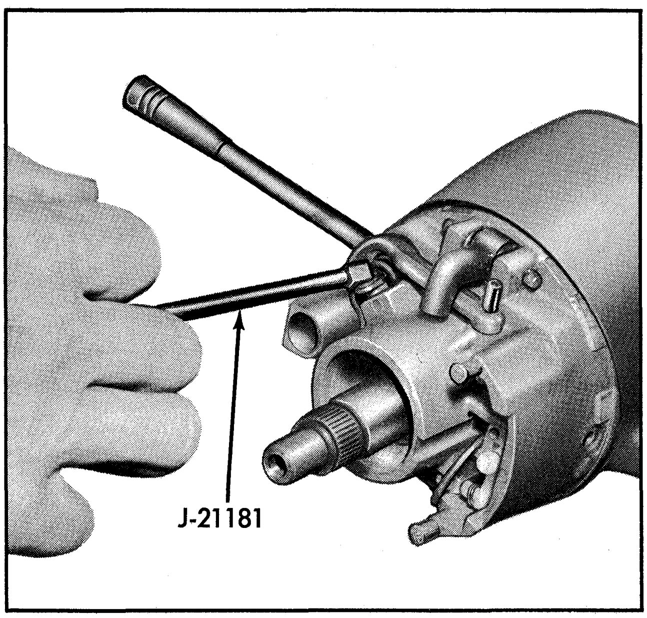



Fig. 9-15 Unseating Springs

9. Pry out horn contact from turn signal actuator housing and let hang loose.

10. Remove turn signal cover with tool J-21180 (Fig. 9-14).

*CAUTION: <u>Do not</u> use end of shaft to pull cover as tilt socket in column would be damaged.*

11. Remove retainer (Tru-arc snap ring), collapsible spacer, wave washer, retainer, seat, inner race and steering shaft upper bearing.

*NOTE: Collapsible spacer must not be reused.*

12. Remove turn signal switch actuator yoke and detent spring.

13. Remove bulb socket retaining screw.

14. Install tilt release lever, lift up and allow column to full up position, then unseat upper ends of tilt return springs with tool J-21181 (Fig. 9-15) or screwdriver.

15. Remove two pivot pins with tool J-21179 (Fig. 9-16).

16. Disconnect turn signal cable from retainer assembly.

17. Lift tilt lever to disengage lock shoes from pins and remove actuator assembly.

18. Remove tilt springs.

19. Remove horn contact from actuator assembly.

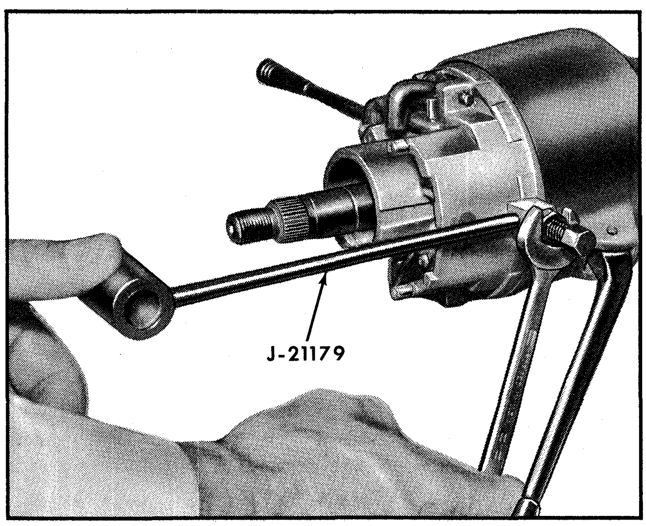



Fig. 9-16 Removing Pivot Pins

20. Drive lock shoe pivot pins from actuator, then remove lock shoes and springs.

*NOTE: Upper shoe has rubber bumper.*

21. Remove actuator spring pins and lever.

22. Remove steering shaft coupling assembly from lower end of steering shaft.

23. Remove lower bearing retaining clamp and spring.

24. Remove steering shaft assembly upward through mast jacket.

25. Remove four support screws and support from mast jacket.

26. Remove turn signal switch control cable by pulling core rearward and twisting cable assembly so that opposite end is removed from steering column jacket.

27. Remove shift tube retainer ring washer from top of shift tube.

28. Remove shift tube bearing retainer from lower end of mast jacket.

29. Remove shift tube downward through column by tapping against bore of lower shift lever.

30. Remove lock plate, wave washer and bowl from upper end of mast jacket.

31. Drive shift lever pivot pin from bowl, then remove shift lever.

## ASSEMBLE

When assembling steering column, apply thin coat of lithium soap grease to all friction parts.

1. Place shift lever spring and lever in bowl, then install lever pin.

2. Install bowl on mast jacket, then wave washer over mast jacket and slide lock plate into position through opening in mast jacket.

3. Install shift tube assembly with felt seal into mast jacket from lower end of jacket.

4. Install thrust washer and retaining ring on upper end of shift tube.

*NOTE: Do not connect cable to bell crank.*

5. Install support on upper end of mast jacket and install four attaching support screws. (The two larger screws go into left-hand holes in support. Torque larger left-hand screws first.) Torque 30-40 lb. in. into upper steering shaft.

6. Install steering shaft assembly into mast jacket from upper end.

7. Install lower bearing in bottom of mast jacket.

8. Install spring and lower bearing retaining clamp on steering shaft.

9. Install steering shaft coupling assembly on lower end of shaft.

10. Install lower roller bearing at steering wheel end of steering shaft.

11. Install actuator lever, pins, and spring on actuator assembly.

12. Install release springs on upper end of lock shoes, then install shoes in actuator and retain with pivot pins.

*NOTE: The upper lock shoe must have rubber bumper installed.*

13. Install lower ends of two return springs on support spring anchor.

14. Connect turn signal switch control on ball crank in turn signal actuator, mounting cable loop inboard. Install cable bracket screw.

15. Install tilt lever into tilt release actuator.

16. Assemble horn contact and wire through actuator assembly and mast jacket.

17. Move tilt lever up slightly to prevent lock shoes from engaging pins, then install actuator assembly over steering shaft.

18. Align actuator assembly pivot pin holes with pin holes in support assembly and install pivot pins.

19. Raise tilt lever and lift upper steering column to maximum up position.

20. Install upper ends of two return springs with tool J-21181, spring installer.

21. Install turn signal actuator yoke assembly and detent spring.

*CAUTION: Check to be sure bell crank is engaged in bracket of yoke assembly.*

22. Install upper steering shaft bearing, inner race, seat, retainer, wave washer, and new collapsible spacer.

23. Install snap ring (Tru-arc) over steering shaft and against collapsible spacer, then place tool J-21179 and 9/16" ID washer over steering shaft.

24. Install the steering wheel nut and turn down until window (cut out) in tool J-21179 is in line with upper edge of snap ring groove (.002") (Fig. 9-17).

25. Remove the steering wheel nut and tool J-21179, tapping snap ring into groove.

26. Check torque of steering shaft, making sure torque is 40 ounce inches plus or minus 5 ounce inches in all tilt positions.

*NOTE: If torque is below specifications, spacer has been over collapsed.*

27. Remove tilt wheel release lever.

28. Install turn signal cover, aligning key in cover into keyway in turn signal actuator.

29. Install tilt and turn signal levers.

30. Replace bulb and indicator assembly.

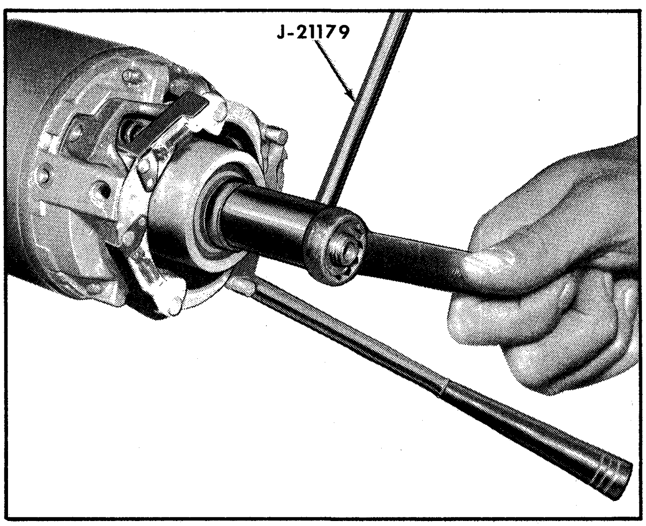



Fig. 9-17 Seating Spacer

31. Install steering wheel.

32. Install neutral safety and back up lamp switch lever and switch on mast jacket.

33. With upper turn signal actuator in center position, place loop in control cable over switch carrier pin and connect control cable to switch. Index steering wheel to full down position and mount switch to jacket with two screws.

## CENTERING SPHERE - DISASSEMBLE

1. Remove the spring from between steering shaft couplings (sockets) in the following manner:

*CAUTION: When removing spring, use care to prevent losing spring since it is under compression.*

A. Turn upper shaft slightly from centerline of lower shaft.

B. Using narrow bladed screwdriver, compress spring enough to remove it from upper seat, then remove spring.

2. Turn upper shaft 90° from centerline of lower shaft and remove shaft over flats of centering sphere (Fig. 9-18).

3. Remove sphere from upper shaft by rotating so flats on sphere align with socket.

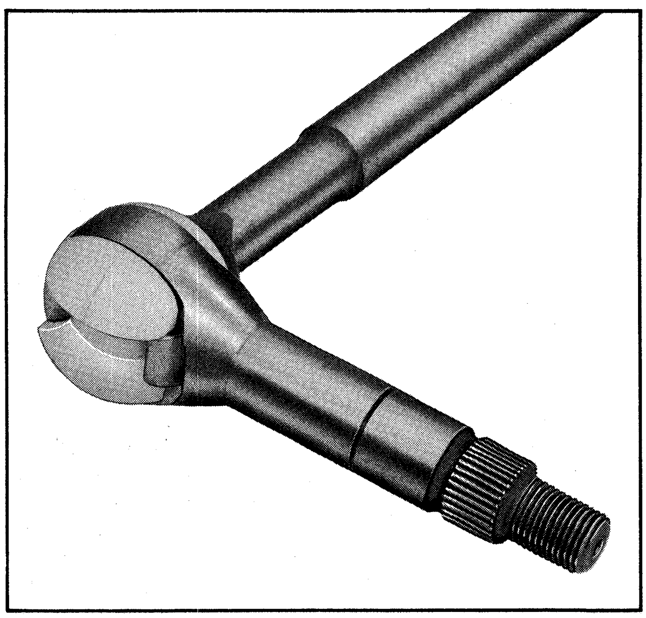


Fig. 9-18 Separating Upper and Lower Shaft

CENTERING SPHERE - ASSEMBLE

1. Place centering spheres in upper shaft socket.

2. Turn spheres so lower shaft can be installed over flat area of spheres. (Approximately 90° from centerline of lower shaft.) Then install lower shaft socket over sphere.

3. Install spring through centering sphere into lower shaft and into upper steering shaft.

### *STEERING COLUMN—INSTALL*

1. Insert lower end of steering column assembly through opening in floor of vehicle, lowering column until steering shaft flange and steering gear housing meet.

2. Install instrument panel bracket and insulator around steering column and insert attaching screws and washers but do not tighten.

3. Securely tighten steering shaft to steering gear retaining bolts.

4. Install steering wheel as outlined under STANDARD STEERING WHEEL - REPLACE or DELUXE STEERING WHEEL - REPLACE.

5. On all but V-8 synchromesh, when steering wheel is drawn down to 1/16" of directional signal housing tighten steering column bracket to instrument panel attaching screws. Adjust clamp on steering gear shaft up against lower bearing assembly and tighten.

6. On V-8 synchromesh adjust steering column so that there is 2-7/16" between the upper edge of the shift lever opening in the steering column housing and the cowl panel (Fig. 9-11). Tighten steering column bracket to instrument panel attaching screws. When steering wheel is drawn down to 1/16" of directional signal housing, tighten flange bolt on flexible coupling. Adjust clamp on steering gear shaft against lower bearing assembly and tighten.

7. Install steering column cover plate and attach with two screws.

8. Insert clutch rod through hole in toe pan and position toe pan around steering column.

9. Install clutch rod insulator through hole in toe pan so that clutch rod is held firmly.

10. Insert four toe pan retaining screws and tighten securely.

11. Position rubber grommet against toe pan.

12. Engage clutch rod with clutch pedal and insert cotter pin.

*NOTE: If clutch rod clevis adjusting nuts were not loosened during disassembly clutch pedal height will probably be correct.*

13. Connect wiring connector at back-up light switch, directional signal and horn wire connector.

14. Connect first and reverse shifter rod to lower lever and second and third shifter rod to upper lever at steering column.

15. Adjust clutch (Section 6).

### *REPLACE STEERING LINKAGE*

Steering connecting rod may be removed from both tie rods, pitman arm and idler arm by removing the ball shaft nut (Fig. 9-4). Since the connecting rod is a solid shaft, it may be replaced by installing new rod and connecting to pitman arm, tie rods, and idler arm.

After steering connecting rod is removed pitman arm may be removed from pitman shaft by removing the nut and lock washer and by using puller J-5504. To install pitman arm on pitman shaft, replace arm, lock washer and nut and tighten to 100-125 lb. ft. torque.

After steering connecting rod is removed, idler arm may be removed by removing two bolts which retain idler support to frame. The idler support and idler arm may then be separated, first threading idler support from bushing and then threading the idler arm from bushing. In reassembling, install bushing in idler arm and tighten to 100 lb. ft. torque. Next thread idler support and seal into bushing until distance between idler arm support lower mounting bolt hole and top of arm is approximately 2.96". Install assembly on frame with two attaching bolts and tighten to 35-45 lb. ft. torque.

Tie rod assembly may be removed from car by removing cotter pin and castellated nut on tie rod ends at steering arms. To separate tie rod and tie rod end, loosen two bolts on tube and clamp assembly, and thread out the part to be replaced. To

reassemble, thread new part into tube and clamp assembly to approximate original location, place tie rod end with dust cover in steering arm, tighten castellated nut securely, and install new cotter pin.

When new tie rods or tie rod ends are installed it is necessary to check toe-in. Check clamp bolts on tie rod adjuster sleeve assembly for tightness (14-20 lb. ft. torque) and make sure bolts are to lower rear and at 45° angle from horizontal with nuts in up position (Fig. 9-4).

Whenever work is done on steering linkage it should be lubricated.

## STEERING GEAR—REMOVE

1. Disconnect pitman arm from pitman shaft using J-5504.

2. Scribe a mark on the worm shaft flange and steering shaft and disconnect lower flange from steering shaft.

3. Remove three steering gear housing to frame bolts.

## STEERING GEAR—DISASSEMBLE

Disassemble and reassemble steering gear and subassemblies on a clean work bench, preferably while the assembly is mounted on holding fixture (J-5205 or J-6448-01).

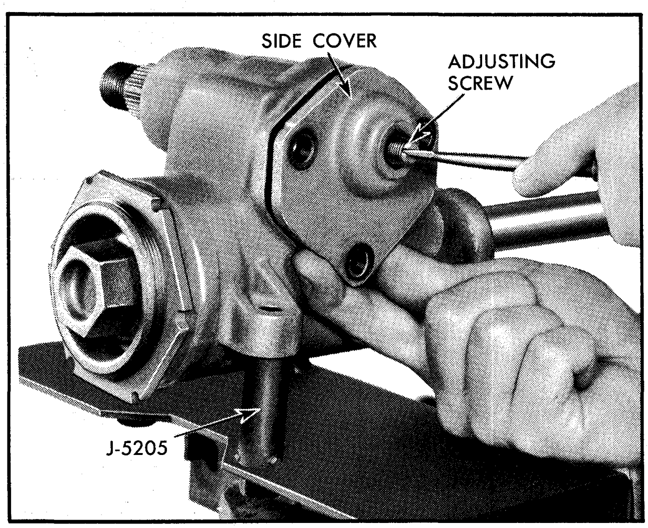



Fig. 9-19 Removing Side Cover

*CAUTION: DO NOT clamp housing in vise. Cleanliness is of utmost importance; therefore, bench, tools, and parts must be kept clean at all times.*

Before disassembling gear, thoroughly clean exterior with suitable solvent and drain as much fluid as possible. Assist draining by turning gear flange through its entire range two or three times.

1. Mount steering gear assembly on holding fixture J-5205.

2. Rotate wormshaft with lower flange assembly until wheel is in center of travel. Remove three side cover screws and adjusting screw nut.

3. Remove side cover and gasket by turning adjusting screw clockwise through cover (Fig. 9-19).

4. Remove adjusting screw from slot in end of pitman shaft. Make sure shim found on adjusting screw remains with screw (Fig. 9-20).

5. Remove pitman shaft from housing using care that threads do not damage seal in housing.

6. Loosen worm bearing adjuster lock nut with brass drift and remove adjuster and lower bearing.

7. Remove lower flange assembly.

8. Push worm and shaft assembly, with ball nut assembly, through bottom of housing and remove upper bearing.

9. Clean grease from worm and shaft assembly and also from inside gear housing.

10. Remove ball nut return guide clamp by removing three screws, remove guides, turn ball nut over and remove balls. Rotating shaft slowly from side to side will aid in removing balls.

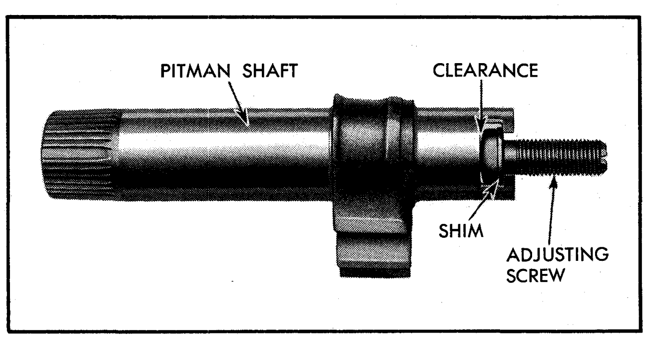



Fig. 9-20 Pitman Shaft and Adjusting Screw

11. Remove ball nut from worm.

*NOTE: Unless all balls are removed nut cannot be removed.*

## CLEANING AND INSPECTION

1. Remove gear housing from holding fixture.

2. Wash all parts in clean kerosene or other suitable solvent.

3. Inspect all bearings, bearing cups, worm groove, bushings, seals, teeth for scoring, wear, pitting, etc. which would necessitate replacement.

4. Inspect housing and cover for sand holes or cracks.

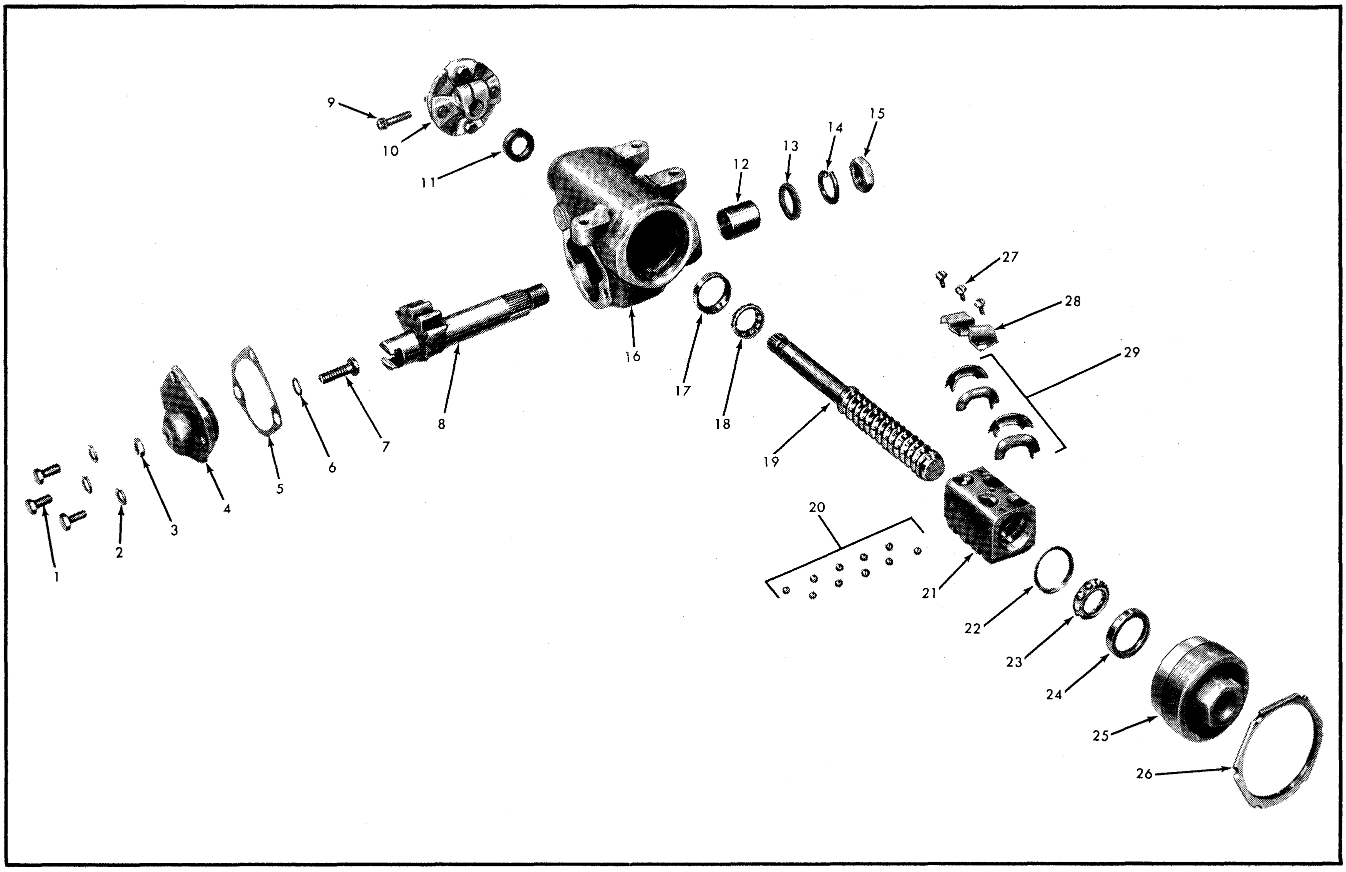
If pitman shaft bushing seal, upper and lower bearing cups, steering gear housing or column jacket are worn excessively or damaged, replace parts.

### *REPLACE PITMAN SHAFT BUSHING*

1. Remove pitman shaft seal.

2. Drive out bushing with tool J-1614 (Fig. 9-22).

3. To install new bushing with same tool, driving bushing in towards center of gear housing. Inner




1. Side Cover Bolts
2. Side Cover Bolt Washers
3. Adjusting Screw Lock Nut
4. Side Cover
5. Side Cover Gasket
6. Adjusting Screw Shim
7. Adjusting Screw
8. Pitman Shaft
9. Flange Assembly Bolt
10. Coupling and Lower Flange Assembly
11. Steering Shaft Seal
12. Pitman Shaft Bushing
13. Pitman Shaft Seal
14. Pitman Shaft Nut Lock Washer
15. Pitman Shaft Nut
16. Steering Gear Housing
17. Upper Bearing Cup
18. Upper Bearing
19. Worm and Steering Shaft
20. Balls
21. Ball Nut
22. Lower Bearing Retainer
23. Lower Bearing (Worm Thrust)
24. Lower Bearing Cup (Worm Thrust)
25. Worm Bearing Adjuster
26. Worm Bearing Adjuster Lock Nut
27. Ball Return Guide Clamp Screws
28. Ball Return Guide Clamp
29. Ball Return Guides

Fig. 9-21 Standard Steering Gear—Exploded View

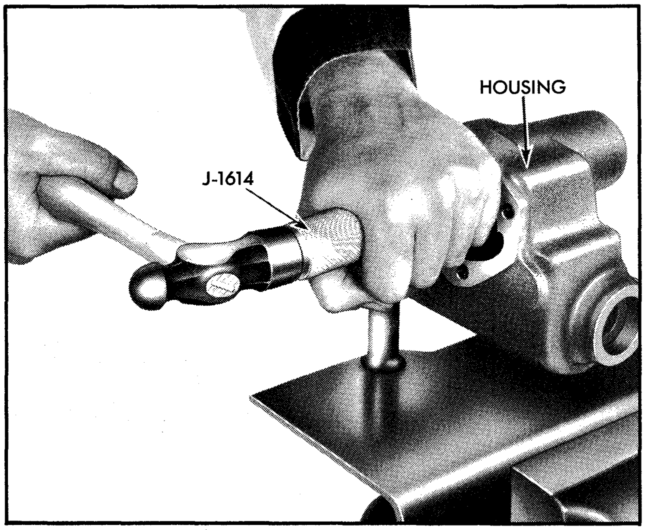



Fig. 9-22 Removing Pitman Shaft Bushing

end of bushing must be flush with inside surface of housing at the seal seat.

4. Install new pitman shaft seal using suitable socket as driver.

### REPLACE PITMAN SHAFT SEAL

1. Remove pitman shaft seal with screwdriver or suitable tool.

2. Install new seal using suitable socket as driver.

### REPLACE UPPER OR LOWER BEARING CUPS

UPPER CUP

Remove gear housing upper seal assembly. Then using suitable punch, remove upper cup from gear

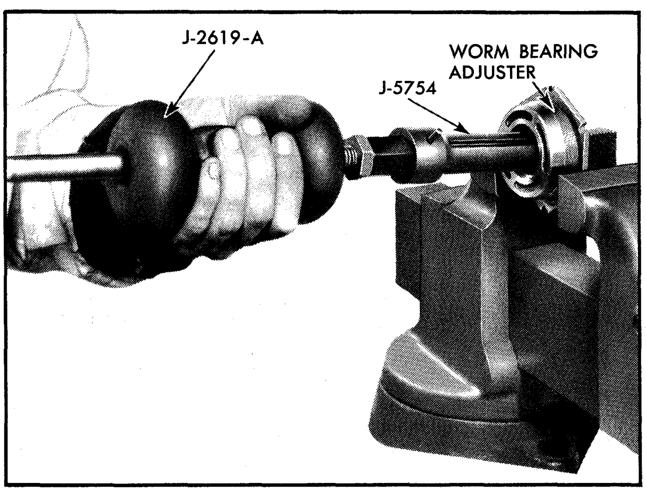



Fig. 9-23 Removing Bearing Cup from Worm Bearing Adjuster

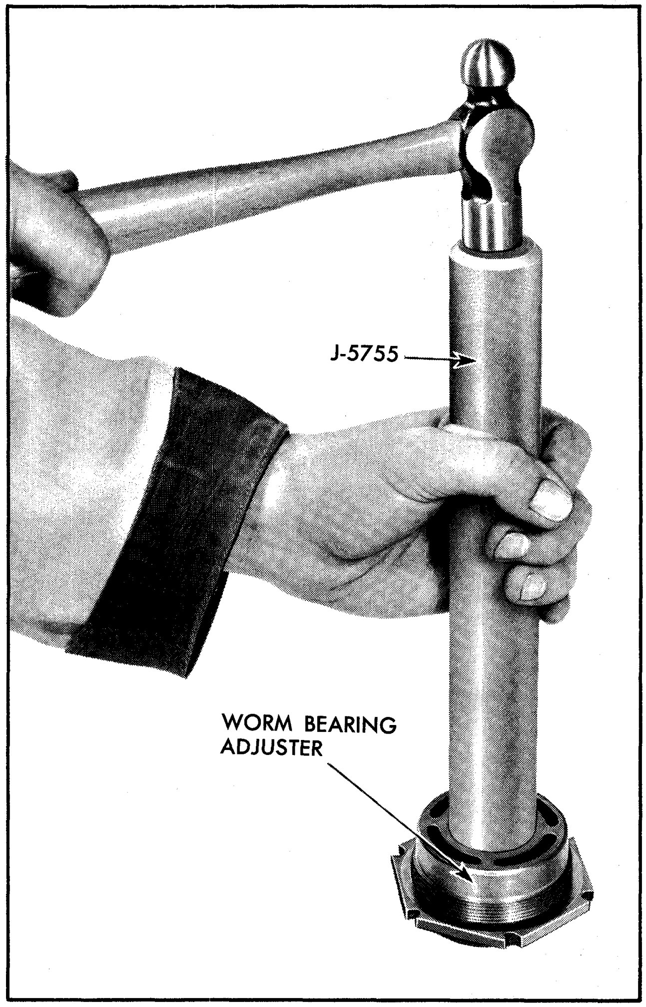



Fig. 9-24 Replacing Bearing Cup

housing. Install bearing cup in housing using J-5755. Replace seal.

LOWER CUP

1. Remove lower cup from worm bearing adjuster (Fig. 9-23) using tool J-5754 and J-2619B slide hammer.

2. Install bearing cup in worm bearing adjuster (Fig. 9-24) using tool J-5755.

### STEERING GEAR—ASSEMBLE

*NOTE: All seals, bushings and bearings should be prelubricated before assembly.*

1. Position ball nut on shaft so that deep side of teeth are located as shown in Fig. 9-25.

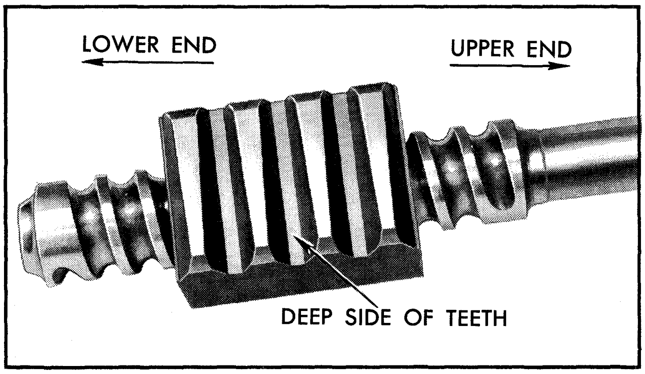



Fig. 9-25 Ball Nut Properly Installed on Shaft

2. Install 19 balls in each circuit of ball nut (rock steering shaft slightly to aid in installing balls) and insert 6 balls in each return guide using petrolatum to hold balls in place. Install return guide clamp and screw.

*CAUTION: Do not rotate worm shaft while installing balls, since balls may enter crossover passage between circuits. This will cause improper operation of ball nut.*

3. Place upper bearing on worm shaft. Center ball nut on worm, then slide worm shaft, bearing and nut into housing.

4. Place lower bearing in worm adjuster and install bearing retainer over bearing using J-5813. Install adjuster in housing.

*NOTE: Adjuster should be installed just tight enough to hold bearing races in place. Install adjuster lock nut loosely.*

5. Slip lower flange assembly on shaft and turn steering gear from one extreme to the opposite to make certain there are no unusual binds and remove flange assembly.

*NOTE: Never allow ball nut to strike the ends of the ball races in worm due to the possibility of damage to ball guides.*

a. Using a 11/16"-12 point deep socket and inch pound torque wrench, measure torque required to keep wrench in motion when off high point of gear. Torque required should be 5 to 9 lb. in.

b. If torque does not meet above specifications loosen worm bearing adjuster lock nut (Fig. 9-26) and turn adjuster to bring torque within 5 to 9 lb. in. limits.

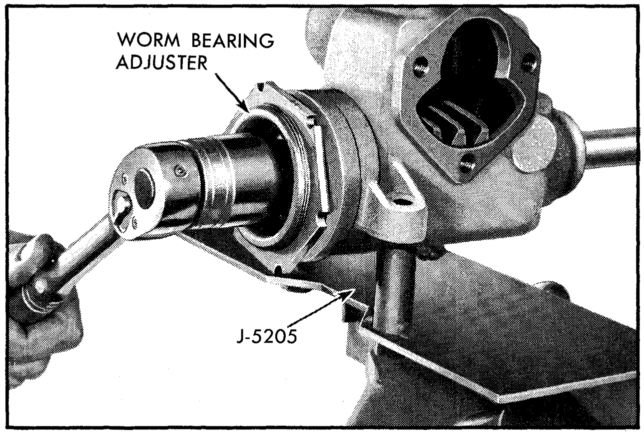



Fig. 9-26 Adjusting Worm Bearing Preload

c. Tighten lock nut and recheck torque.

d. Remove 11/16" socket and torque wrench.

6. Install pitman shaft adjusting screw and selective shim in pitman shaft (Fig. 9-27).

*NOTE: Screw must be free to turn, but have no more than .002" end play. If end play of screw in slot is too tight or too loose, select new shim to give proper clearance. Shims are furnished in four thicknesses: .063", .065", .067", and .069".*

7. Position pitman shaft seal on pitman shaft and seat seal using suitable socket as a driver.

8. Install pitman shaft and adjusting screw with sector and ball nut teeth positioned as shown in Fig. 9-28.

9. Install side cover and gasket on adjusting screw, turning screw counterclockwise until it projects through cover 5/8" to 3/4".

10. Install two cover attaching bolts. Tighten to 25 to 40 lb. ft.

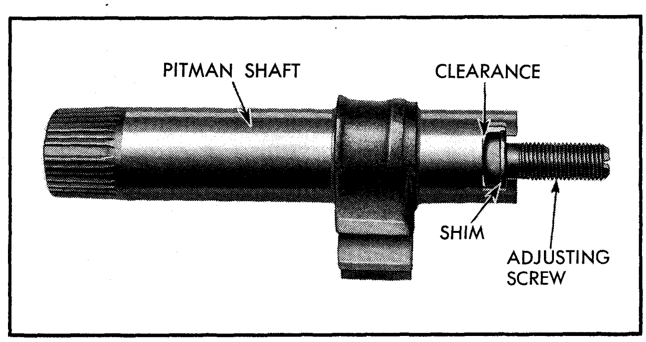



Fig. 9-27 Pitman Shaft and Adjusting Screw

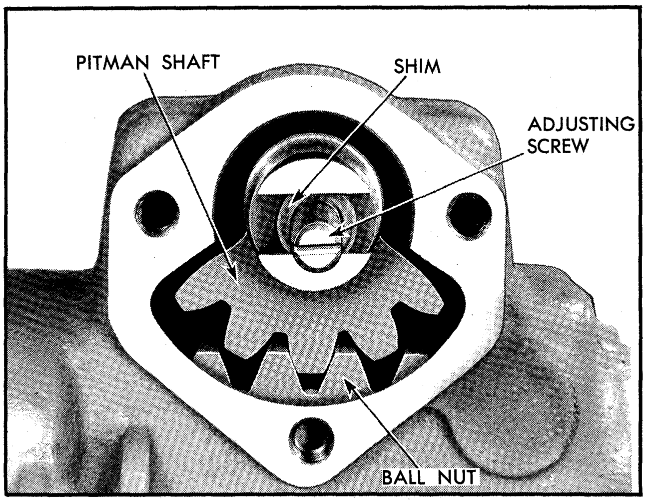



Fig. 9-28 Positioning Pitman Shaft and Ball Nut

11. Tighten pitman shaft adjusting screw so that teeth on shaft and ball nut engage but do not bind. Final adjustment will be made later.

12. Fill steering gear with all-season steering gear lubricant and install third cover attaching bolt. Tighten to 25 to 40 lb. ft.

13. Adjust sector preload and ball nut backlash as follows:

a. Place a 11/16"-12 point socket and lb. in. torque wrench over end of worm shaft.

b. Tighten pitman shaft adjusting screw as necessary to obtain a reading of 4 to 9 lb. in. torque, in excess of thrust bearing preload, when the worm gear is turned through the high point (Fig. 9-29).

c. Tighten pitman shaft adjusting screw lock nut to 18 to 27 lb. ft. and recheck adjustment.

## STEERING GEAR—INSTALL

1. Align scribe marks on steering and worm shaft flange.

2. Position steering gear assembly in car.

*NOTE: Metal to metal contact between flanges on stub shaft assembly and steering shaft assembly will transmit and amplify gear noise to driver.*

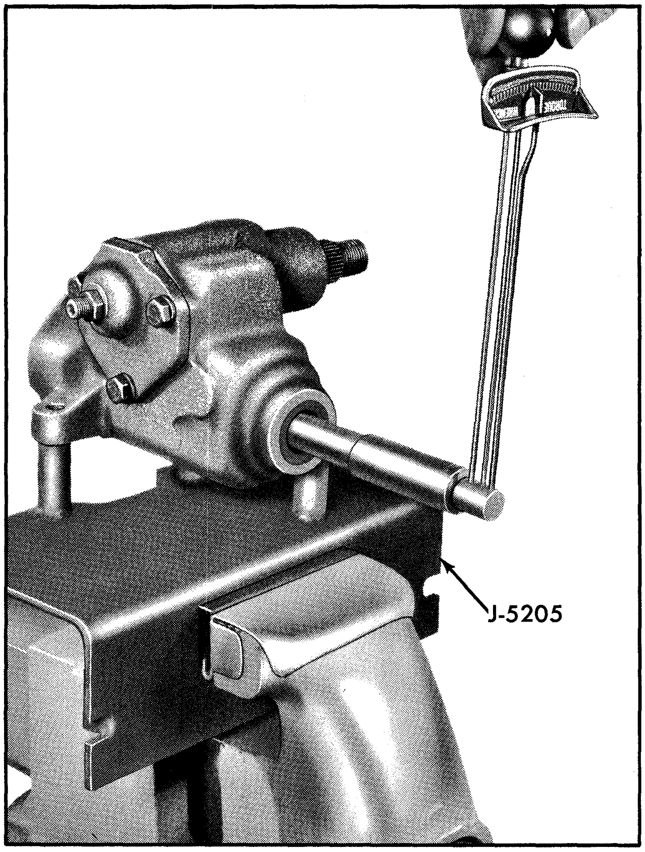



Fig. 9-29 Adjusting Worm Gear Through High Point

3. Install steering housing to frame bolts and tighten housing to frame bolts to 55-75 lb. ft. torque.

4. Install pitman arm and secure with lock washer and nut. Tighten nut to 110-140 lb. ft. torque.

5. Install two flange attaching nuts and lock washers and tighten to 15-20 lb. ft. torque.

6. Align steering column jacket and shaft assembly and steering gear so head of lower coupling bolt has 1/4 inch clearance from flange on steering shaft. Adjust the steering mast jacket assembly up or down. A metal to metal contact at this point will transmit the slightest noise to the driver.

7. Be sure pins are properly positioned.

## STEERING GEAR TROUBLE DIAGNOSIS

**(See SUSPENSION TROUBLE DIAGNOSIS AND TESTING, Section 3, for Additional Information.)**

| CONDITION | CAUSE | REMEDY |
|---|---|---|
| **Hard Steering while driving** | Frozen steering shaft bearings | Replace bearings |
| | Lower coupling flange rubbing against steering shaft | Loosen bolt and assemble properly |
| | Steering wheel rubbing against gearshift bowl. | Adjust jacket endwise |
| | Steering gear or connection adjustment too tight | Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball. Readjust if necessary |
| | Front spring sagged | Check front end jounce height. Jounce height should be approximately the same at both wheels. Compare dimensions with those on car having about same mileage and equipment and believed to be standard. Replace front springs if sagged |
| | Frame bent or broken | Repair frame as necessary |
| | Steering knuckle bent | Install new buckle |
| | Ball joint galled or too tight | Replace ball joint |
| | Low or uneven tire pressure | Inflate tires to recommended pressure |
| | Steering gear or connections adjusted too tight | Test steering system for bind with front wheels off floor. Adjust, as necessary, and lubricate |
| | Insufficient or incorrect lubricant | Check lubricant in steering gear and lubricate steering system as required |
| | Excessive caster | Check caster and adjust as necessary |
| | Suspension arms bent or twisted | Check camber and caster. If arms are out of car, compare with new arms and replace if bent |

| CONDITION | CAUSE | REMEDY |
|---|---|---|
| **Poor return of Steering** | Frozen steering shaft bearings | Replace bearings |
| | Lower coupling flange rubbing against steering shaft | Loosen bolt and assemble properly |
| | Steering wheel rubbing against gearshift bowl | Adjust jacket endwise |
| | Tires not properly inflated | Inflate to specification |
| | Incorrect caster or toe-in front wheels | Adjust to specification |
| | Tight steering linkage | Lubricate - check end plugs |
| | Tighteness of suspension ball joints | Lubricate |
| | Steering adjustment tight | Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball. Readjust if necessary |
| | Tight sector to worm nut adjustment | Adjust in car to specification |
| | Worm bearing adjustment too tight | Remove gear and adjust to specification |
| | Nut and worm preload too tight | Remove gear and replace balls as required |
| **Car leads to one side or the other** | Due to front end misalignment | Adjust to specification |
| **Excessive wheel kickback or loose steering** | Lash in steering linkage | Adjust parts affected |
| | Excessive lash between pitman shaft sector and nut | Adjust to specification |
| | Ball nut and worm preload | Check worm bearing adjustment and overcenter adjustment. Check for looseness in steering linkage. If complaint still exists, remove rack piston and worm, and change balls to obtain specified preload. |
| | Ball joints too loose | Replace ball joints |
| | Front wheel bearings incorrectly adjusted or worn | Adjust and/or replace front wheel bearings |
| **Hard Steering when parking** | Lack of lubrication in linkage or front suspension | Add lubricant where needed |
| | Tires not properly inflated | Inflate to recommended pressure |

## SPECIFICATIONS

Type . . . . . . . . Saginaw Recirculating Ball Nut
Steering Gear Ratio Overall . . . . . . . . . 28.32:1
Lubricant . . . . . . . . . See Lubrication Section
Lubricant Capacity . . . . . . . . . 11 Fluid Ounces

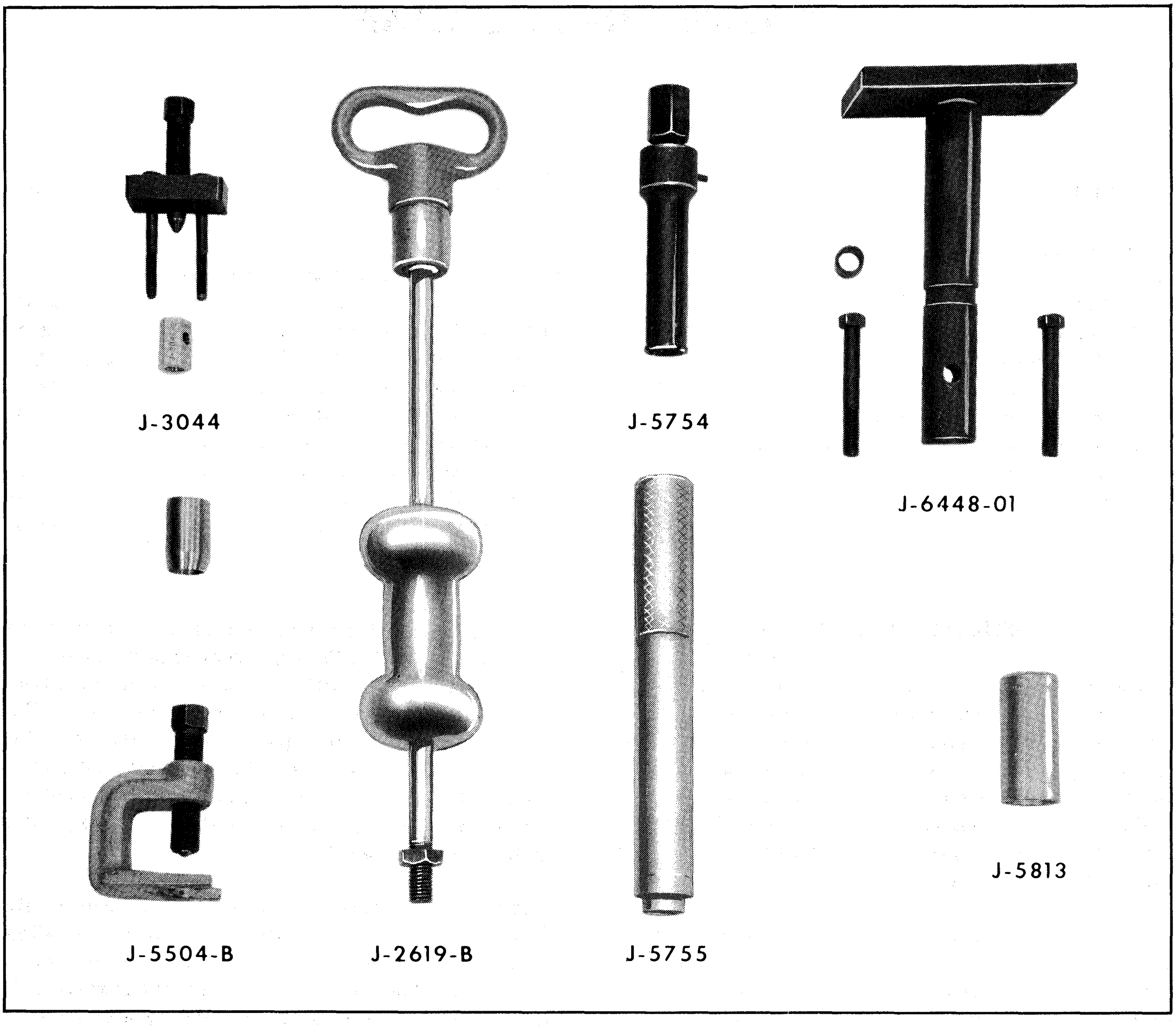
Worm Bearing Preload . . . . . . . . . 5-9 lb. in.
Sector and Ball Nut Back
Lash . . . Worm Bearing Preload plus 4-9 lb. in.
(Total Thrust Bearing Adjustment, Pitman Shaft Adjustment, and Drag not to exceed 14 lb. in.)

## WRENCH TORQUE SPECIFICATIONS

**(Torque in lb. ft. unless otherwise specified.)**

| TORQUE | APPLICATION |
|---|---|
| | Steering Gear and Pitman Arm |
| 55-75 | Bolt - Steering Gear Assembly to Frame |
| 110-140 | Nut - Pitman Arm Shaft (Standard Steering) |
| | Steering Wheel |
| 20-35 | Nut - Steering Wheel to Steering Column Shaft |
| | Steering Column Bracket |
| 10-35 Lb. In. | Nut - Steering Column Upper Bracket to Instrument Panel |
| 10-20 | Screw - Steering Column Lower Bracket to Mtg. Bracket |
| 10-35 Lb. In. | Screw - Steering Column Opening Cover Plate to Floor |
| 10-20 | Bolt - Steering Column Shaft Jacket Lower Clamp |
| | Steering Linkage |
| * | Fitting - Steering Gear Connecting Rod Lubrication |
| * | Fitting - Steering Knuckle Tie Rod Ball Lubrication |
| 14-20 | Bolt and Nut - Steering Knuckle Tie Rod Tube Clamp |
| 35-45 | Bolt - Steering Connecting Rod Idler Lever Support to Frame |
| 30-40 | Nut - Steering Linkage (Ball Socket Stud) to Pitman Arm |
| 30-45 | Nut - Steering Connecting Rod to Tie Rod Ball Stud |
| 30-40 | Nut - Steering Connecting Rod to Idler Arm |
| 30-45 | Nut - Steering Tie Rod Ball Stud to Steering Knuckle |

*NOTE (*) Torque not a requirement, other means of control and/or specifications used, checked for alignment, bottoming, height and/or leaks.*




| | |
|---|---|
| J-544-A | Tension Scale (0-4#) |
| J-2619-B | Slide Hammer |
| J-3044 | Steering Wheel Puller |
| J-5504-B | Pitman Arm Puller |
| J-5754 | Steering Shaft Worm Bearing Cup Remover (Use with J-2619-B) |
| J-5755 | Steering Shaft Worm Bearing Cup Remover |
| J-5787 | Pitman Shaft Seal Protector |
| J-5813 | Pitman Shaft Seal Installer |
| J-6448-01 or J-5205 | Steering Gear Holding Fixture |

Fig. 9-30 Standard Steering Gear—Special Tools

# POWER STEERING GEAR

## CONTENTS OF THIS SECTION



## GENERAL DESCRIPTION

The Rotary Valve Safety power steering gear assembly operates entirely on displacing oil to provide hydraulic oil pressure assists only when turning. As the entire gear assembly is always full of oil, all internal components of the gear are immersed in oil making periodic lubrication unnecessary. In addition this oil acts as a cushion to absorb road shocks that may be transmitted to the driver.

The steering shaft, hydraulic valve, worm and the rack-piston nut are all in line making a compact and space saving gear. All oil passages are internal except the pressure and return hoses between the gear and pump.

The rotary valve feature is a new concept in driver ease and control. It provides a smooth transmission through the driving range of steering wheel effort. A torsion bar transmits the "road feel" to the driver. Response of the steering gear to effort applied to the steering wheel has been greatly increased. This increased response gives the driver greater control and minimizes over-steering.

## DESIGN

Design of the new gear with fewer parts reduces the over-all size and weight. In addition, this simple design requires fewer service tools. Being a self-bleeding unit the steering gear requires no external bleeding.

The mechanical element of this steering gear is a low-friction, high-efficiency recirculating ball system in which steel balls act as a rolling thread between the steering worm and rack-piston nut. The rack-piston nut is one piece and is geared to the sector of the pitman shaft. Lash between the pitman shaft and rack-piston nut is maintained by an adjusting screw which is retained in the end of the pitman shaft gear (Fig. 9A-1).

The rotary valve assembly is contained in the gear housing. It is shown schematically in Figs. 9A-2, 9A-3 and 9A-4, and is an open-center, rotary type valve. The valve spool is inside the valve body and is held in a neutral position by a torsion bar attached to one end of the valve body through the torsion bar cap and extends through this valve. The other end of the torsion bar is attached to a stub shaft assembly which in turn is splined to the gear flange that bolts to the steering shaft flange.

Twisting of the torsion bar allows the valve spool to displace or move its position in relation to the valve body, thereby, directing oil to the proper area in the gear to provide a hydraulic assist on turns. During the turn the steering worm turns in the same direction as the turn. This causes the rack-piston nut to move which in turn applies a turning effort to the pitman shaft gear.

While the advantages of the rotary valve safety power steering gear design are many, the most important of these are light turning effort, increased

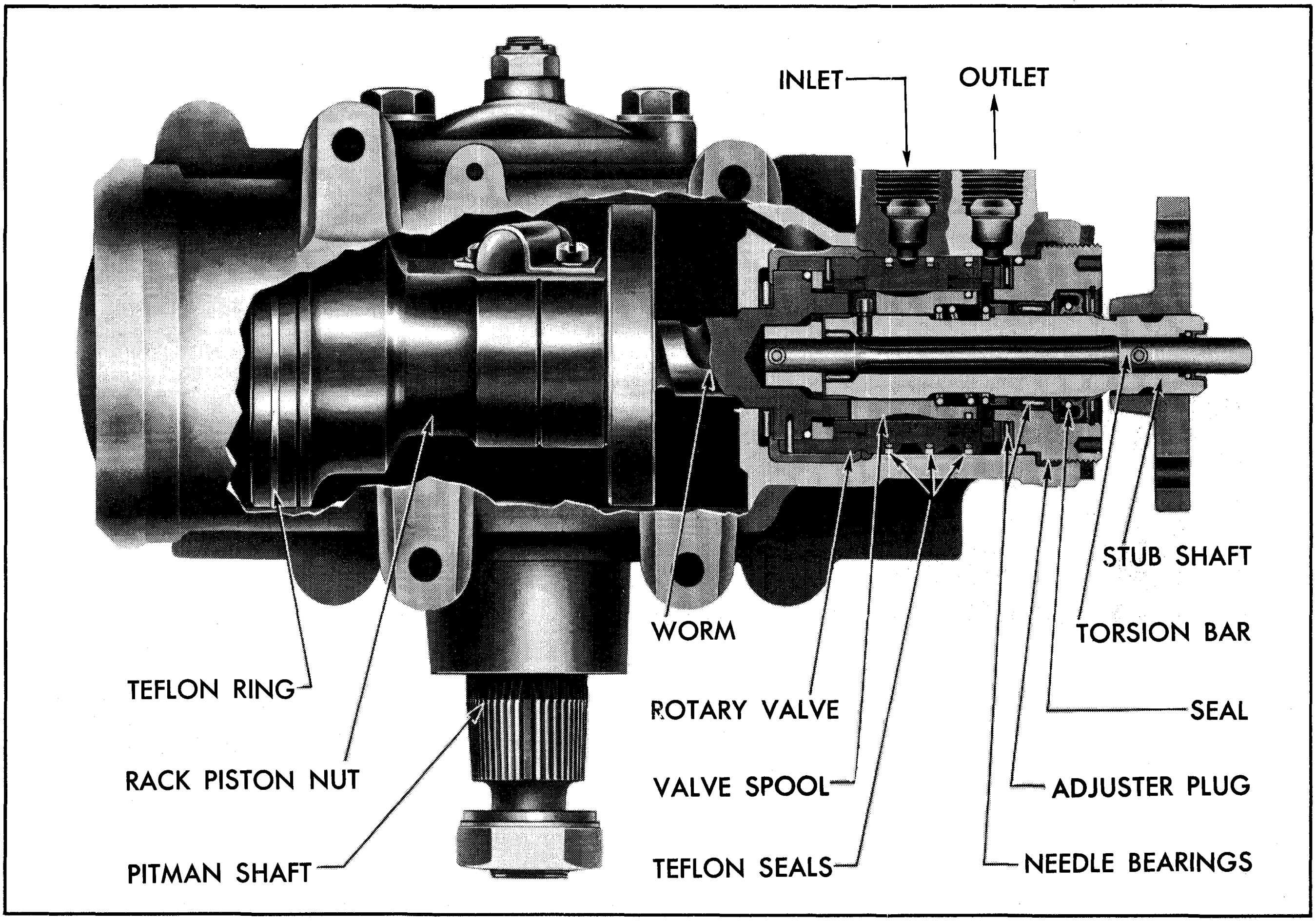



Fig. 9A-1 Power Steering Gear—Sectional View

response, smoothness of gear operation and a "fail-safe" feature. This feature provides for manual operation if for any reason the power system should fail or become inoperative.

## OPERATION

### OPERATING PRESSURES

Under normal driving conditions, the hydraulic oil pressure in the power cylinder should not exceed 40-100 psi. Pressure for turning corners should be approximately 100-600 psi. Parking pressure, the most difficult of turning conditions, should range from 600 psi to 1300 psi depending upon roadbed conditions and the weight of the car. The steering gear ratio is 17.5 to 1. The over-all steering ratio of the power steered car is approximately 22 to 1. During normal driving, the steering wheel effort will range from 1 pound to 2 pounds. The parking effort will range from 2 pounds to 3 1/2 pounds, again depending upon roadbed conditions.

### OIL FLOW—STRAIGHT-AHEAD POSITION

The rotary valve assembly contains a valve spool which is a selective slip fit inside the valve body and is positioned so the grooves and lands on the outside surface of the valve spool align with the lands and grooves on the inside surface of the valve body (Fig. 9A-2). Grooves are slightly wider than their mating land and clearance on both sides of the land provides the "open" position. A stub shaft assembly (stub shaft and a torsion bar pinned together at one end) extends through and is attached to one end of the rotary valve assembly; a pin locks the stub shaft and the valve spool together and a pin in the valve body retains the torsion bar assembly.

In the straight-ahead or neutral position, oil flows from the power steering pump through the "open" position of the rotary valve assembly (Fig. 9A-2), and back to the power steering pump reservoir without circulating in the power cylinder in which the rack-piston is located. Since all passages are open, flow resistance is low in the neutral position, and

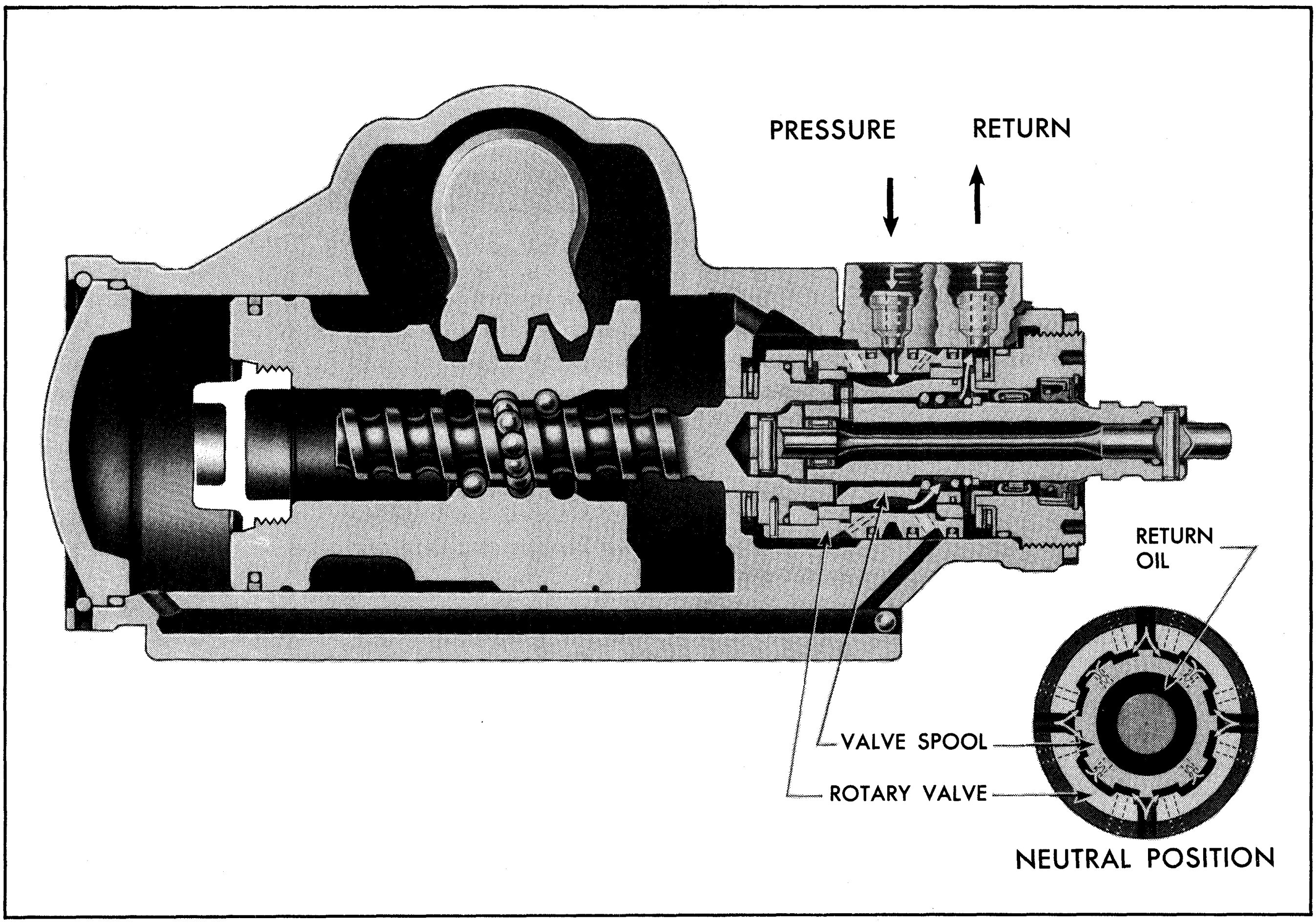



Fig. 9A-2 Oil Flow—Straight Ahead Position

since the valve remains in this position at all times except when steering in turns, the power required to operate the pump is at the minimum.

The power cylinder is full of oil at all times, although in the straight-ahead position the pressure on both sides of the rack-piston is equal and very low.

Oil from the steering gear pump flows through a passage in the gear housing to an annular groove around the valve body. Four holes evenly spaced around the valve are drilled from the bottom of this groove through the valve body wall to a groove on the inside surface of the valve body. Eight pressure holes evenly spaced around the valve body are also drilled through the valve body wall but these are through a land portion on the inside surface of the valve body with one hole on each side of the four inlet pressure holes.

When no twisting force is applied to the steering gear stub shaft assembly from the steering wheel there is sufficient clearance between the land groove alignment of the valves to permit oil to flow between the valves. Oil flows back to the pump via four drilled holes through the valve spool wall that align with a groove on the stub shaft assembly. From here oil flows around the stub shaft to an area between the rotary valve assembly and adjuster plug assembly, through the return port to the pump.

Oil in the power cylinder acts as a cushion that absorbs road shocks that may be transmitted to the steering wheel for increased safety and reduces driving fatigue. In addition, this oil lubricates all internal components of the gear, making it unnecessary to lubricate the gear at any time.

### *OIL FLOW—RIGHT TURN POSITION*

When a right turn is executed, oil from the power steering pump flows through the rotary valve assembly, through the steering gear housing to an area between the housing end plug and the rack-piston

nut to assist in forcing the rack to turn the pitman shaft and steering linkage for assist in the turn.

When the steering wheel is turned to the right, resistance to turning is encountered between the front wheels and the roadbed tending to twist the stub shaft assembly. Since the stub shaft assembly is pin locked to the torsion bar at one end and the opposite end indexes the valve spool by a pin on the stub shaft, the twisting action moves the valve spool to the right in relation to the valve body. This slight movement causes the land in the valve spool to restrict the right side opening between the valve spool land and valve body lands and opens the clearance on the left side of the spool lands (Fig. 9A-3).

The right openings being restricted permits oil to flow through the unrestricted passages to the left (Fig. 9A-3) to an annular groove around the valve body which aligns with an oil passage in the gear housing.

Oil is then directed to flow between the housing end plug and the rack-piston nut to force the rack upward permitting the steering worm to screw into the rack-piston nut. This forces the pitman shaft to turn and reduces driver turning effort in executing the right turn. The oil in the upper end of the cylinder is simultaneously forced out through the rotary valve and back to the pump reservoir.

The higher the resistance to turning between the roadbed and the front wheels, the more the valve spool is displaced, and the higher the oil pressure on the lower end of the rack-piston nut. Since the amount of valve displacement and, consequently, the amount of hydraulic pressure built in the cylinder is dependent upon the resistance to turning, the driver is assured of the proper amount of smooth hydraulic assistance at all times.

As the driver stops applying steering effort to the steering wheel and then relaxes the wheel, the spool valve is forced back into its neutral position by the "untwisting" of the torsion bar. The spool valve

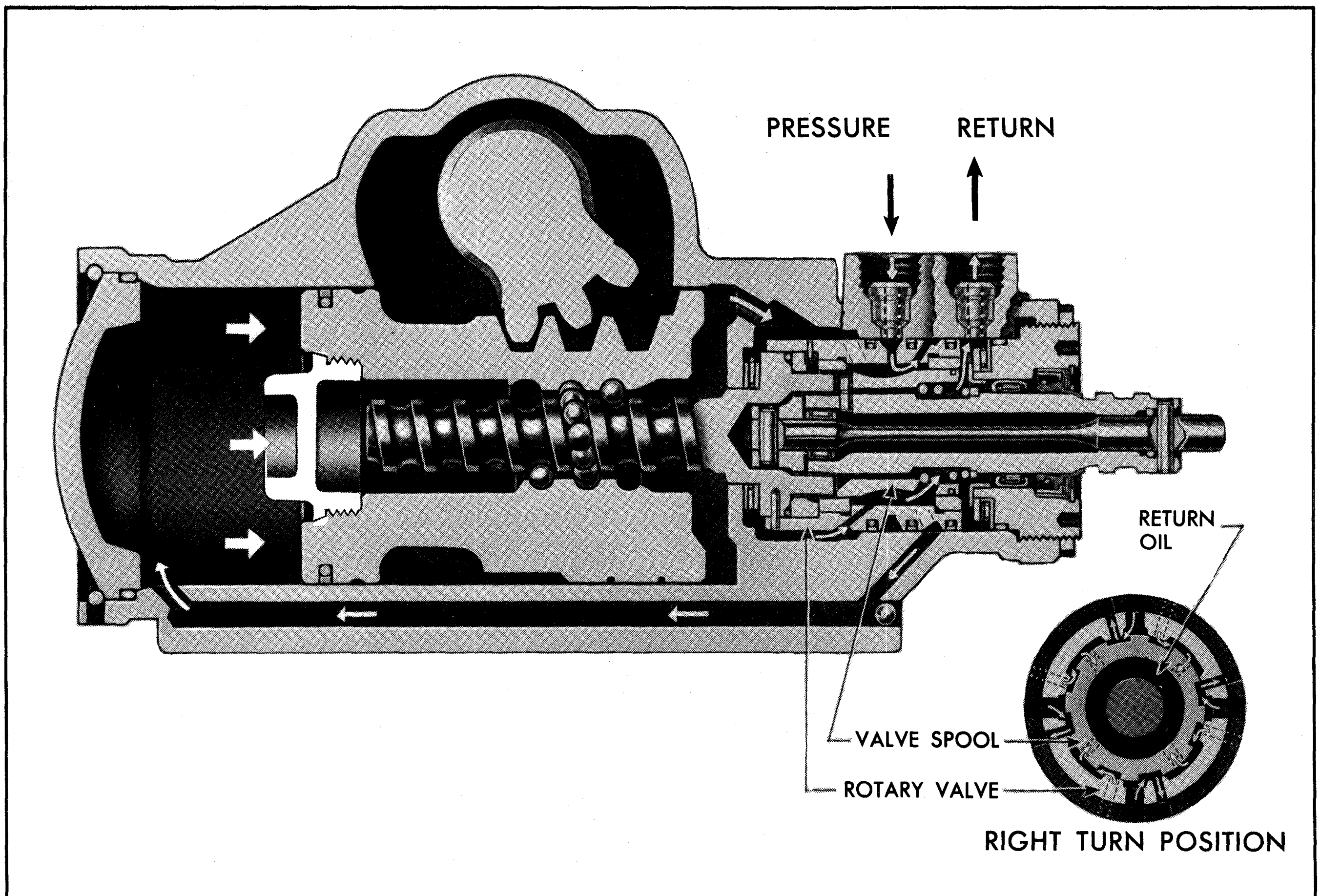



Fig. 9A-3 Oil Flow—Right Turn Position

lands and grooves align themselves with the grooves and lands in the valve body providing a balanced clearance between the land-groove alignment. When this happens, the oil pressure is again equal on both sides of the rack-piston nut and the steering geometry of the car causes the wheels to return to the straight-ahead position.

### *OIL FLOW—LEFT TURN POSITION*

Executing a left turn causes oil to flow from the power steering pump through the rotary valve assembly and to the area between the rotary valve assembly and the rack-piston nut rack via a drilled passage in the steering gear housing. This is to assist in forcing the rack to turn the pitman shaft and linkage for added assist in the turn.

When the steering wheel is turned to the left, resistance to turning is encountered between the front wheels and the roadbed tending to twist the stub shaft assembly. Since the stub shaft assembly is pin-locked to the torsion bar at one end and the opposite end indexes the valve spool by means of a pin in the stub shaft, the twisting action moves the valve spool to the left in relation to the valve body. This slight movement causes the land on the valve spool to restrict the left side opening between valve spool lands and the valve body lands and opens the clearance on the right side of spool lands (Fig. 9A-4).

The left openings being restricted permits oil to flow through the unrestricted passages to the right to an annular groove around the valve body which aligns with an oil passage in the gear housing.

Oil is then directed to flow between the rotary valve assembly and the rack-piston nut via a drilled passage in the steering gear housing to force the rack-piston nut downward. This forces the pitman shaft to turn and reduces driver turning effort in executing the left turn. The oil in the lower end of the housing is simultaneously forced out through the rotary valve from a drilled passage in the housing and back to the pump reservoir.

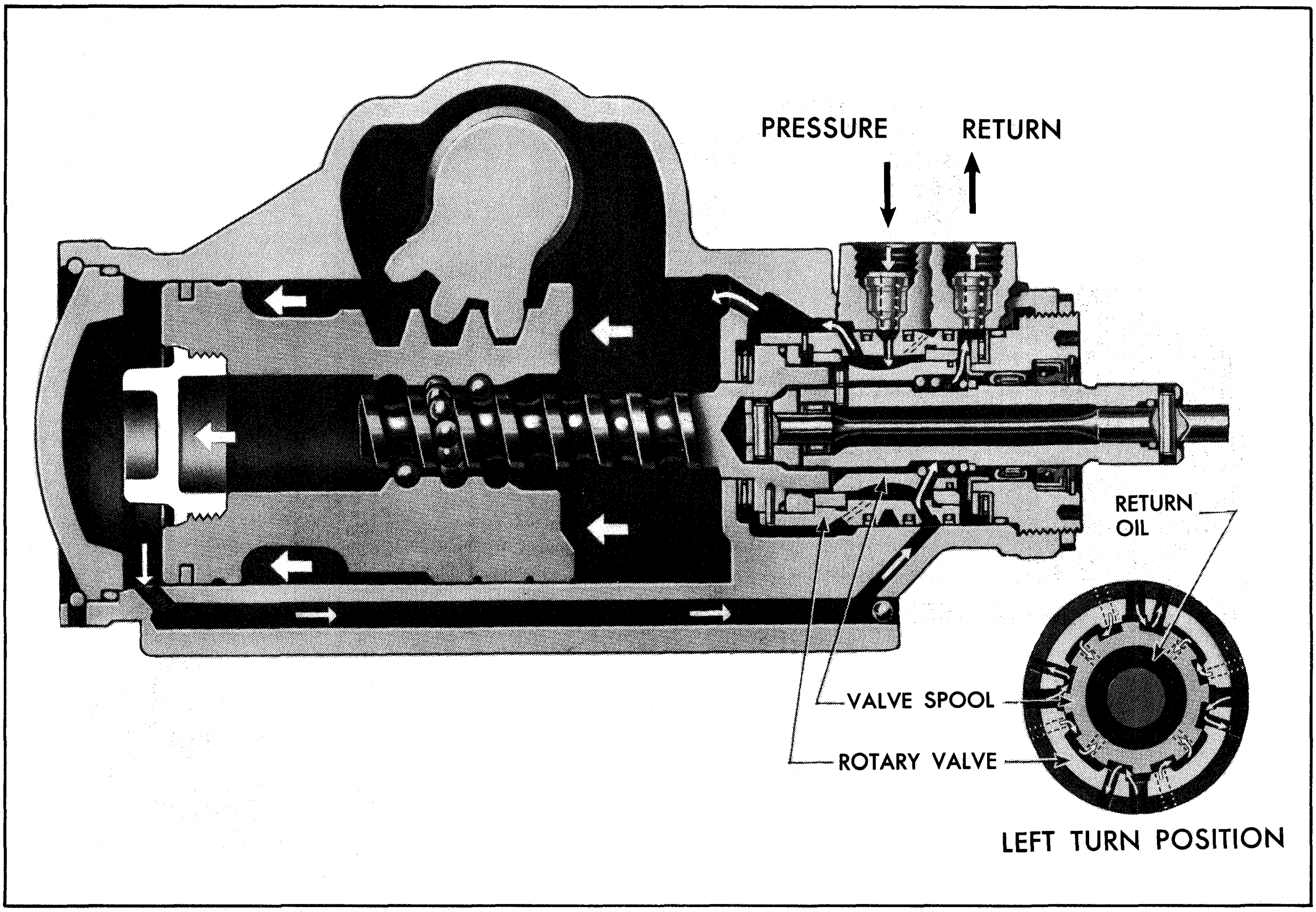



Fig. 9A-4 Oil Flow—Left Turn Position

The higher the resistance to turning between the roadbed and the front wheels, the more the valve spool is displaced, and the higher the oil pressure on the upper end of the rack-piston nut. Since the amount of valve displacement and, consequently, the amount of hydraulic pressure built in the cylinder is dependent upon the resistance to turning, the driver is assured of the proper amount of smooth hydraulic assistance at all times.

As the driver stops applying steering effort to the steering wheel and then relaxes the wheel, the spool valve is forced back into its neutral position by the "untwisting" of the torsion bar. The spool valve lands and grooves align themselves with the grooves and lands in the valve body providing a balanced clearance between the land-groove alignment. When this happens, the oil pressure is again equal on both sides of the rack-piston nut and the steering geometry of the car causes the wheels to return to the straight-ahead position.

## PERIODIC SERVICE RECOMMENDATIONS

Since the steering gear is constantly lubricated, it is only necessary to periodically check the level in the pump reservoir. See Specifications on page 9A-25 for system capacity.

## ADJUSTMENTS ON CAR

Before making adjustments to the power steering gear to correct conditions such as, shimmy, hard or loose steering, road shock, wander or weave, a check should be made of front end alignment, shock absorbers, wheel balance, or for tight front wheel bearings, loose steering rod ends or loose pitman arm.

### CHECK STEERING GEAR ADJUSTMENTS

1. Disconnect steering gear connecting rod from pitman arm.

2. Remove horn button or horn ring from steering wheel.

3. With inch pound torque wrench attached to a 5/8"-12 point socket, measure and record readings taken from the following steering gear positions. See Fig. 9A-5.

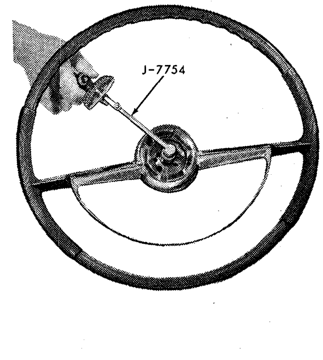



Fig. 9A-5 Checking Steering Gear Adjustment

*NOTE: DO NOT use a torque wrench having maximum torque reading of more than 100 inch pounds. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one half of this total as the average torque.*

a. One full turn off center high point. This reading represents adjuster plug preload plus resistance offered by seals and bearings and should not exceed 7 lb. in. torque. If the reading is below 3 lb. in. torque, it may indicate some lash in the thrust bearing.

*NOTE: If the reading for "a" is not in specifications, correct adjuster plug bearing preload as follows: Loosen adjuster plug lock nut, using drift or similar tool, and move flexible coupling (by turning steering wheel) as necessary to permit installation of tool J-7624 on adjuster plug (Fig. 9A-10). Tighten plug as required to obtain proper reading (3-5 lb. in.) and tighten adjuster plug lock nut. If after obtaining proper adjuster plug bearing preload in "a" and the torque reading in "b" is not within specification, then DO NOT remove gear assembly to refit rack-piston balls unless a complaint of loose steering is received. Upon such a complaint, a thrust adjustment ("a") and over center adjustment ("c") should correct the problem if it lies in the steering gear.*

b. One-half turn off center high point. This reading represents resistance offered in "a" above and also worm preload as determined by the size of the balls used in the rack-piston nut. This reading should be 0.5 to 5.0 lb. in. torque higher than the reading obtained in "a" above.

c. Through center high point. This reading represents resistance offered in "b" above and also pitman shaft lash. This reading should be 3 to 6 lb. in. torque higher than the reading obtained in "b" above, and should not exceed 14 lb. in.

4. If reading in step "3c" above is not within specifications, loosen pitman shaft gear lash adjuster nut and adjust to load specified in "c", using 7/32" allen wrench. Tighten lock nut to 20 to 30 lb. ft. torque.

*NOTE: Final adjustment should always be made in a clockwise or downward direction.*

5. Reassemble horn button or horn ring to steering wheel.

6. Reassemble connecting rod to pitman arm. Tighten nut to 40-50 lb. ft.

## MINOR REPAIRS

The following operation may be performed with the steering gear in the car.

### REMOVAL OF PITMAN SHAFT SEALS WITH GEAR IN CAR

*NOTE: Removal of seals can be accomplished with the steering gear in the car using hydraulic pressure from the gear assembly to force the seals out of pitman shaft bore.*

1. Remove pitman arm retaining nut and lockwasher.

2. Remove pitman arm using tool J-5504.

3. Remove pitman shaft outer dust seal retaining ring using J-4245 pliers.

4. Remove outer dust seal using screwdriver or similar tool and place a cloth around housing and pitman shaft to absorb oil leakage from seal bore.

5. Hold a clean dry pan under the gear housing and with engine running, momentarily turn steering gear to extreme left position for not more than two seconds. This will build up pressure on upper side of piston and in pitman shaft chamber forcing seals and inner back-up washer out of bore.

*NOTE: If pressure of oil does not remove seals, turn off engine, remove pitman shaft assembly and remove seals in normal manner being careful not to score the seal bore in housing.*

6. Turn off engine.

7. Remove steering gear assembly to replace seals.

## STEERING GEAR—REMOVE

1. Disconnect pressure and return hose assemblies from housing.

2. Disconnect pitman arm from pitman shaft using J-5504.

3. Scribe mark on steering shaft worm shaft flange and disconnect gear lower flange from steering shaft.

4. Remove gear housing to frame bolts noting number and location of gear to frame shims (if any).

5. Remove steering gear assembly.

## STEERING GEAR—DISASSEMBLE

Disassemble and reassemble steering gear and sub-assemblies on a clean work bench, preferably while the assembly is mounted on a holding fixture (J-5205 or J-6448-01) as shown in Fig. 9A-6.

*CAUTION: DO NOT clamp housing in vise.*

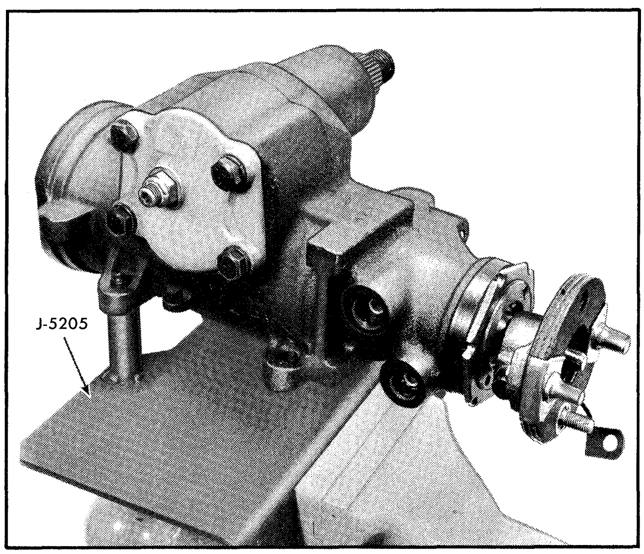



Fig. 9A-6 Steering Gear Mounted on Tool J-5205

Cleanliness is of utmost importance; therefore, bench, tools, and parts must be kept clean at all times.

Before disassembling gear, thoroughly clean exterior with suitable solvent and drain as much fluid as possible. Assist draining by turning gear flange through its entire range two or three times.

### REMOVE HOUSING LOWER END PLUG AND RACK-PISTON NUT END PLUG

1. Remove end plug retaining ring as shown in Fig. 9A-7.

2. Rotate gear (stub shaft) flange to the left and force end plug out of housing and discard end plug "O" ring seal.

*CAUTION: DO NOT turn flange any farther than absolutely necessary or balls from ball nut and worm circuit may escape from this circuit and lay loose inside the rack-piston nut chamber.*

3. Remove rack-piston nut end plug retaining ring using 1/2" square drive (from socket set).

### REMOVE PITMAN SHAFT GEAR AND SIDE COVER

1. Remove side cover retaining screws and washers.

2. Rotate cover as necessary to see when pitman shaft is centered in gear housing opening while rotating gear (stub shaft) flange. See Fig. 9A-8.

3. Remove pitman shaft and cover assembly.

4. Remove side cover "O" ring seal and discard.

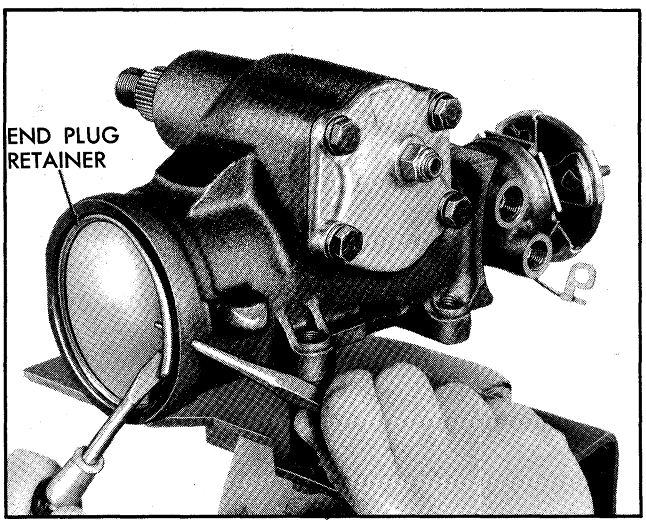



Fig. 9A-7 Removing End Plug Retaining Ring

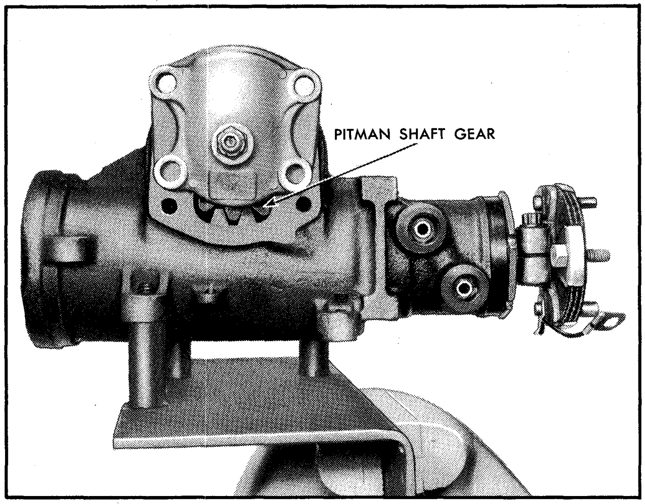



Fig. 9A-8 Position of Pitman Shaft Gear for Removal

### REMOVE RACK—PISTON NUT

1. Holding arbor tool J-7539 against the end of steering worm, rotate stub shaft flange to the left until rack-piston is free from worm. See Fig. 9A-9.

2. With arbor in rack-piston, remove rack-piston nut from housing bore.

*NOTE: The arbor prevents balls from falling out of rack-piston nut.*

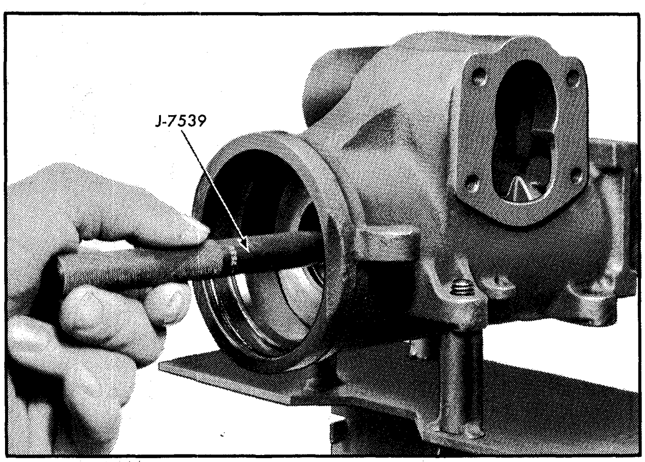



Fig. 9A-9 Arbor J-7539 Against End of Steering Worm

***REMOVE ADJUSTER PLUG ASSEMBLY, ROTARY VALVE WITH WORN SHAFT AND PIN ASSEMBLY AS AN INTEGRAL UNIT***

1. Remove flange locking bolt and remove flange.

2. Remove adjuster plug lock nut using punch or suitable spanner wrench such as J-972 or J-7624.

3. Remove adjuster plug assembly using a spanner as shown in Fig. 9A-10.

4. Push on end of worm shaft with a hammer handle while pulling on stub shaft with slight rotary motion.

5. Remove adjuster plug, rotary valve and worm shaft assembly as an integral unit.

6. Remove adjuster plug from rotary valve and torsion bar by pulling straight out (Fig. 9-11).

7. Separate worm shaft and valve assembly by pulling apart.

8. Remove lower bearing and discard torsion bar cap to worm "O" ring seal (in the Rotary Valve). See Fig. 9A-12.

9. Remove lower bearing races and bearing (these parts may come out with worm shaft or remain in the housing).

10. Remove adjuster plug "O" ring seal and discard.

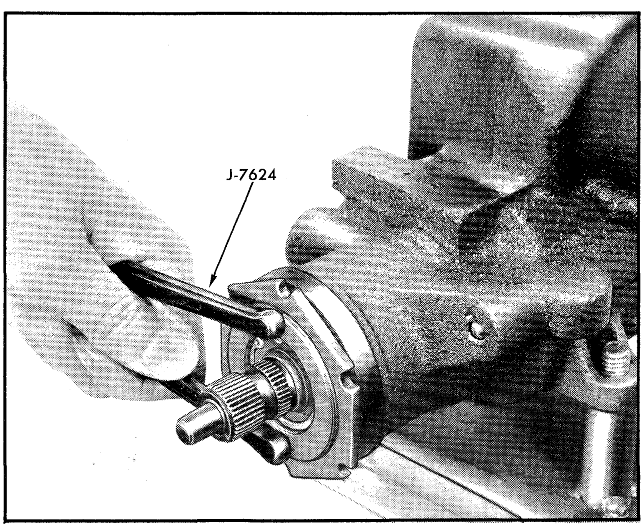



Fig. 9A-10 Removing Adjuster Plug Assembly

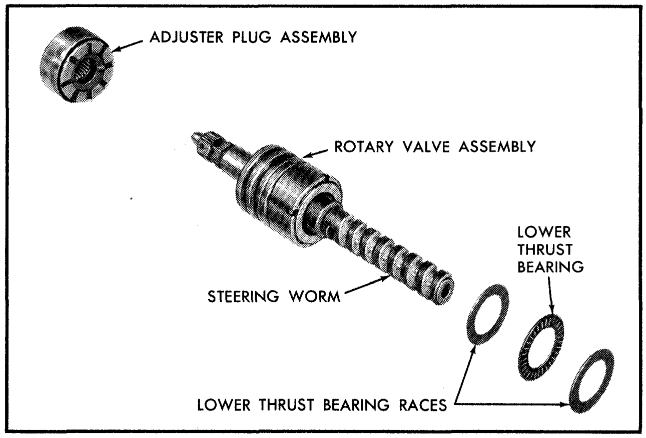



Fig. 9A-11 Adjuster Plug Removal

***DISASSEMBLE PITMAN SHAFT GEAR AND SIDE COVER***

1. Hold lash adjuster with 7/32" allen wrench and remove lash adjuster nut and discard.

2. Screw lash adjuster out of side cover.

*NOTE: Do not disassemble pitman shaft and component parts as these are serviced as an assembly. See Fig. 9A-13.*

***DISASSEMBLE RACK—PISTON NUT***

1. Place the rack-piston nut assembly on a clean cloth.

2. Remove arbor tool J-7539, ball return guide, and balls making sure all of the balls are caught on the cloth (11 bright and 11 black).

3. Remove and discard Teflon ring and back-up seal from rack-piston nut.

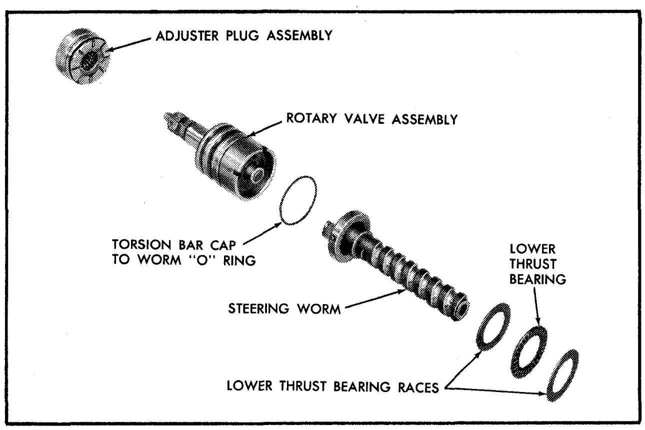



Fig. 9A-12 Location of Torsion Bar Cap to Worm "O" Ring

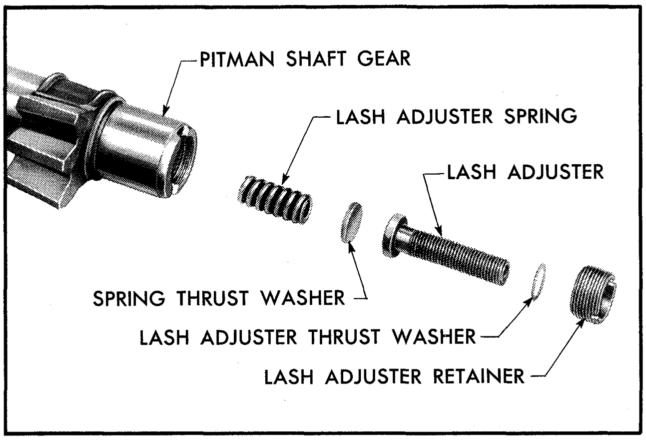



Fig. 9A-13 Parts in End of Pitman Shaft Gear
—DO NOT DISASSEMBLE—

### VALVE SPOOL DAMPENER "O" RING—REPLACE (ONLY IF NECESSARY DUE TO "SQUAWK" IN GEAR)

The rotary valve assembly includes the valve body, valve spool and the stub shaft assembly. All these parts are precision units and are hydraulically balanced at the factory.

Under no conditions are parts in this unit to be replaced or interchanged with other parts or units. If unit parts are scored or damaged the entire rotary valve assembly is to be replaced.

*NOTE: If the valve spool dampener "O" ring requires replacement perform the following operations.*

1. Work spool spring onto bearing diameter of the stub shaft and remove spool spring.

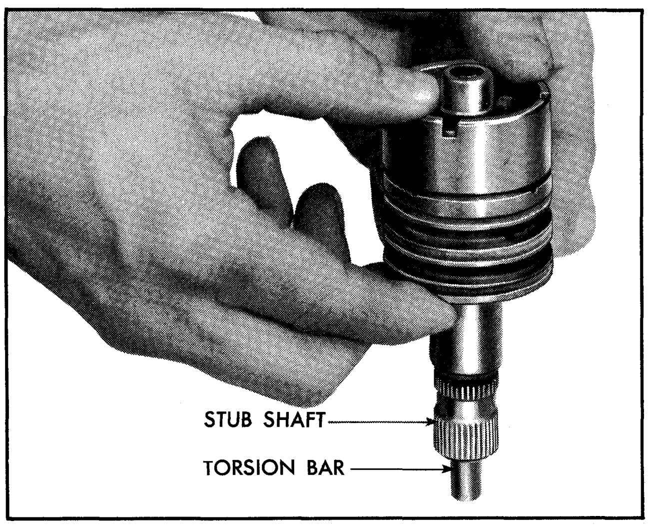



Fig. 9A-14 Tapping to Loosen Valve Spool

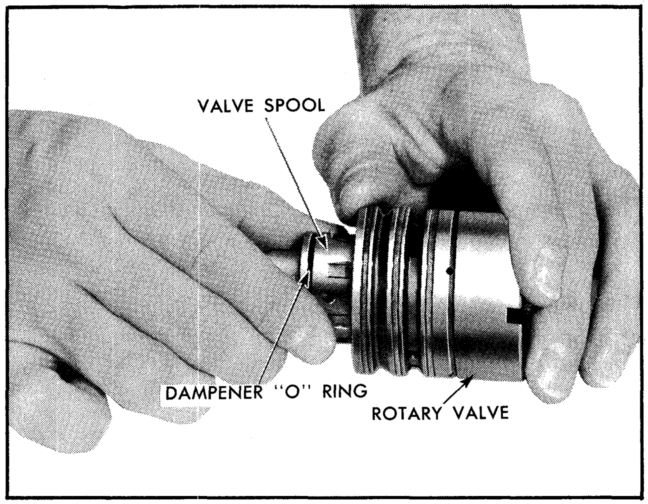



Fig. 9A-15 Removing Valve Spool from Rotary Valve

2. Tap end of stub shaft assembly gently against workbench to remove valve spool (Fig. 9A-14).

*CAUTION: The diametrical clearance between the valve body and the spool may be as low as .0004". The slightest cocking of the spool may jam it in the valve body (Fig. 9A-15).*

3. Remove and discard valve spool dampener "O" ring.

4. Install valve spool dampener "O" ring seal in valve spool groove, then lubricate seal in type A hydraulic fluid. Do not allow seal to twist in the groove.

5. With notch end of spool towards valve body, install spool, aligning spool notch with pin in stub shaft. See Fig. 9A-16.

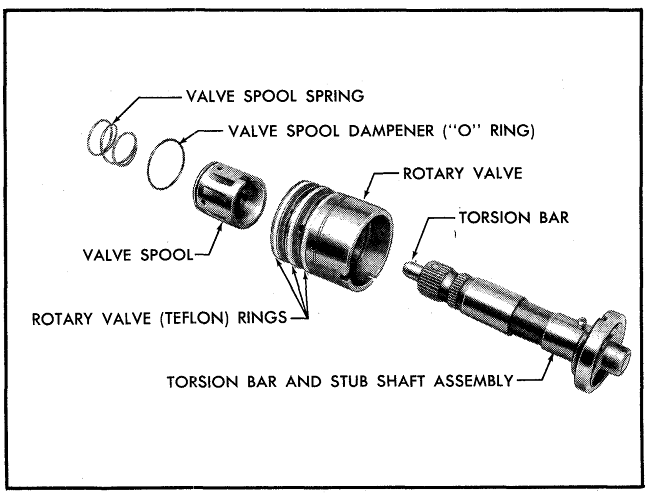



Fig. 9A-16 Rotary Valve—Exploded View

*CAUTION: Because of the small clearance between the valve spool and valve body, extreme care must be taken when assembling these parts. Push the spool evenly and slowly with a slight oscillating motion until spool reaches drive pin. Before pushing spool completely in, make sure dampener "O" ring seal is evenly distributed in spool groove. Slowly push spool completely in, with extreme care taken not to cut or pinch the "O" ring seal.*

6. Slide spool spring over stub shaft and work the spring in position.

#### DISASSEMBLE ROTARY VALVE (ONLY IF NECESSARY)

1. Work spool spring onto bearing diameter of the stub shaft and remove spool spring.

2. Tap end of stub shaft assembly gently against workbench to remove valve spool (Fig. 9A-14).

*CAUTION: The diametrical clearance between the valve body and the spool may be as low as .0004". The slightest cocking of the spool may jam it in the valve body (Fig. 9A-15).*

If slight sticking occurs, make a gentle attempt to reverse the removal procedure. If this does not free the spool, it has become cocked in the valve body bore and may be removed later.

3. Remove and discard valve spool dampener "O" ring.

4. Remove stub shaft, torsion bar (small diameter bar extending through stub shaft) and valve cap assembly by tapping end of torsion bar lightly with a plastic hammer. This will dislodge the cap from valve body cap pin. See Fig. 9A-16. Do not disassemble stub shaft assembly. The parts are pinned together and are serviced as an assembly.

5. If valve spool has become cocked as described in step 3, it can now be freed as follows:

   a. Inspect parts to determine in which direction the spool is cocked.

   b. A few very light taps with a soft plastic or rawhide hammer should align and free the spool in the bore.

   c. Remove and discard "O" ring dampener seal from valve spool.

6. Carefully remove and discard valve body Teflon rings and ring back-up "O" ring seals.

#### DISASSEMBLE HOUSING

1. Remove pitman shaft outer dust seal back-up washer retaining ring using pliers J-4245.

2. Remove outer dust seal back-up washer.

3. Remove seal (double lip) by inserting offset screwdriver between seal and back-up washer and prying out of housing.

*CAUTION: Do not damage housing bore when removing seal.*

4. Remove back-up washer.

5. Remove seal (single lip) by cutting and collapsing seal.

*CAUTION: Do not damage housing bore when removing seal.*

6. If pitman shaft needle bearings are to be replaced, remove bearing by driving out of housing using tool J-6278-1 with adapter J-6278-3. See Fig. 9A-17.

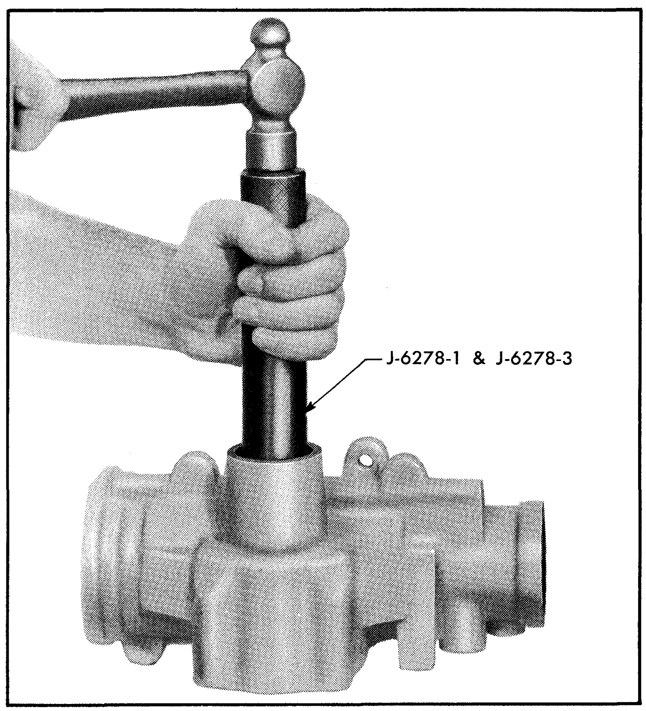



Fig. 9A-17 Removing Pitman Shaft Needle Bearing

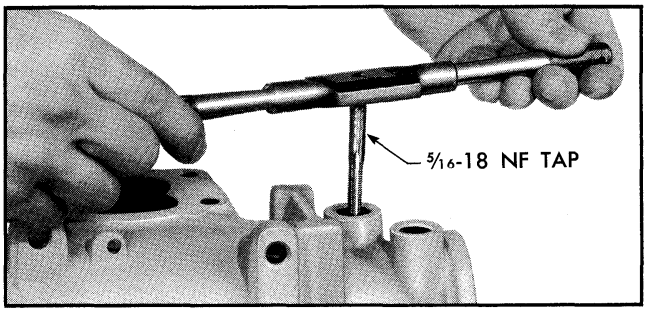



Fig. 9A-18 Tapping Connector Hole

7. If connectors are to be removed, tap threads in holes of connectors using 5/16-18 NF tap. See Fig. 9A-18.

8. Remove connectors by using threaded bolt into tapped holes with washer and nut as extractor (Fig. 9A-19).

## CLEANING AND INSPECTION

Carefully wash all parts in a suitable cleaning solvent.

*CAUTION: Do not use solvent on oil seals and "O" rings which are going to be replaced (Fig. 9A-20).*

### INSPECTION OF PITMAN SHAFT GEAR AND SIDE COVER

1. Inspect pitman shaft bearing surface in side cover for excessive wear or scoring. If badly worn or scored, replace side cover and bushing assembly.

2. Check pitman shaft sector teeth, bearing and seal surfaces and replace if badly worn, pitted or scored.

3. Check lash screw for end play.

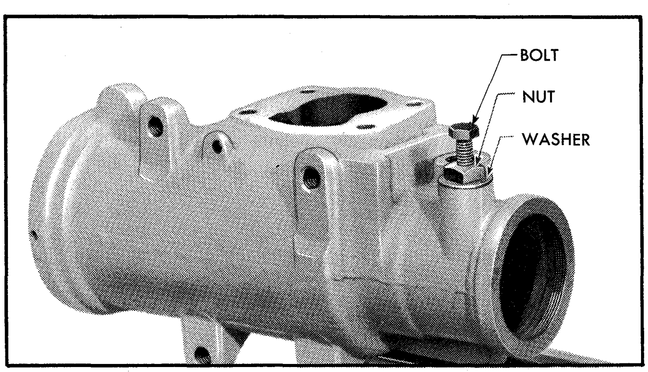



Fig. 9A-19 Removing Connector

If end play is noticed in step 3, replace pitman shaft gear assembly.

### INSPECTION OF RACK—PISTON NUT AND WORM

1. Inspect worm and rack-piston nut grooves and all of the balls for excessive wear or scoring. If either the worm or rack-piston nut needs replacing, both must be replaced as a matched assembly.

2. Inspect ball return guides, making sure that ends where balls enter and leave guides are not damaged.

3. Inspect lower thrust bearing and races for excessive conditions of wear, pitting, scoring, or cracking. If any of these conditions are found, replace the thrust bearing and races.

4. Inspect rack-piston nut teeth for pitting, wear, and scoring.

5. Inspect outside surface of rack-piston nut for wear, scoring, or burrs.

6. Inspect thrust bearing rollers and races for excessive conditions of wear, pitting, scoring, cracking, or brinelling. If any of these conditions are found, replace the thrust bearing assembly.

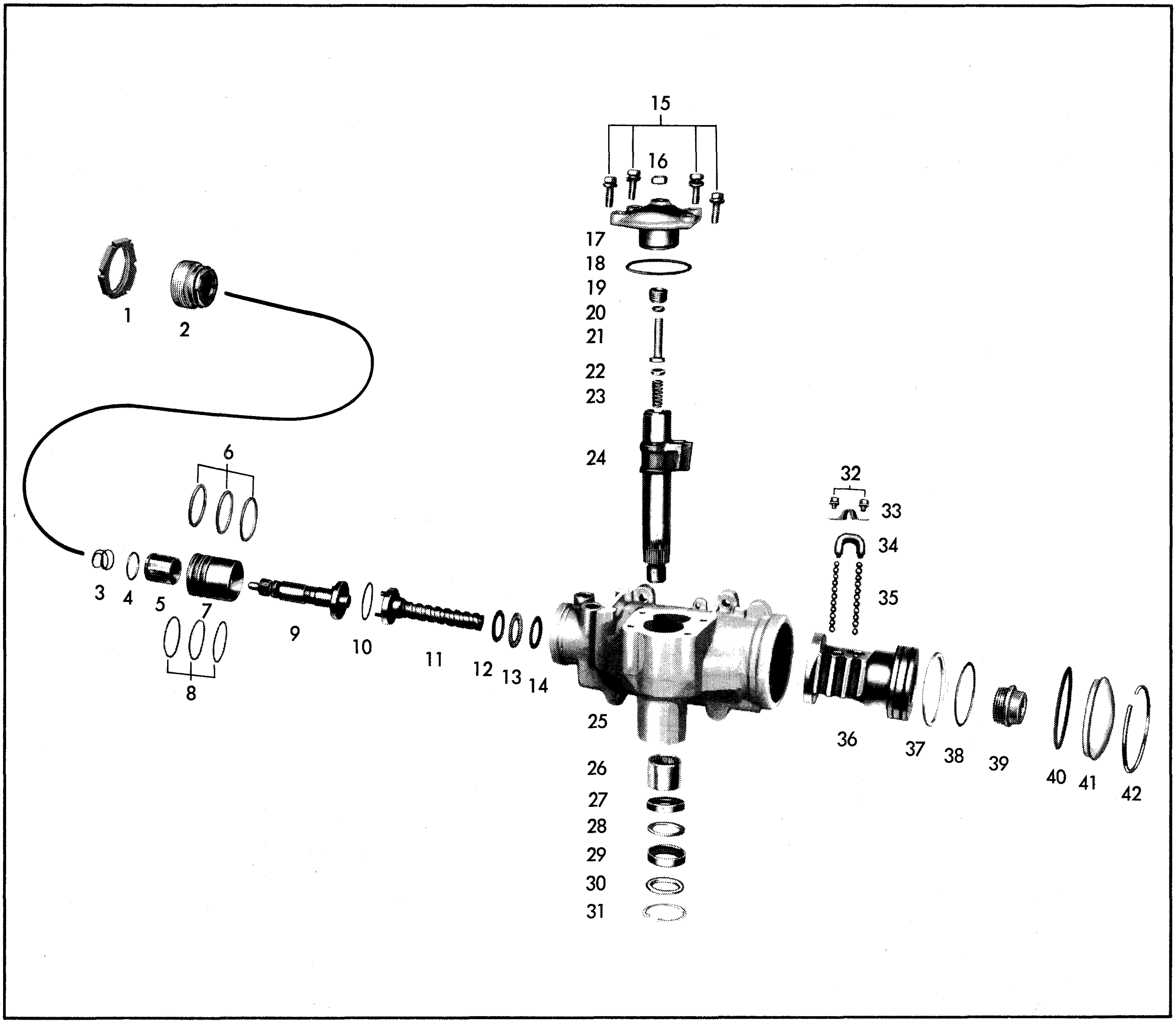
### INSPECTION OF ROTARY VALVE

1. If there was evidence that the torsion bar to stub shaft "O" ring seal has been leaking, (oil leak between the stub shaft and torsion bar at the stub shaft coupling flange) the entire rotary valve assembly should be replaced if it cannot be properly sealed.

*NOTE: Since the seal between the stub shaft and the torus bar at the stub shaft coupling flange is a permanent static seal which should never be replaced, it is permissible to make a permanent mechanical seal installation instead of replacing the entire valve assembly.*

Clean the area around the intersection of the torsion bar and stub shaft and around the balancing pin (both ends) with solvent and/or a wire brush. Dry thoroughly and apply a liquid sealant which would flow into the area between these pieces and then harden. Devcon "B" or equivalent (commercially available products) will work very well in this application.

2. If any part or parts of the rotary valve assembly (including stub shaft assembly) are badly worn,




1. Adjuster Plug Lock Nut
2. Adjuster Plug Assembly
3. Valve Spool Spring
4. Valve Spool Dampener ("O" Ring)
5. Valve Spool ("O" Ring)
6. Rotary Valve Teflon Seals
7. Rotary Valve
8. Rotary Valve "O" Ring Seals
9. Torsion Bar and Stud Shaft Assembly
10. Torsion Bar Cap to Worm "O" Ring
11. Worm Shaft
12. Worm Thrust Bearing Inner Race
13. Worm Thrust Bearing
14. Worm Thrust Bearing Outer Race
15. Side Cover Screws
16. Lash Adjuster Lock Nut
17. Side Cover
18. Side Cover "O" Ring Seal
19. Lash Adjuster Retainer
20. Lash Adjuster Thrust Washer
21. Lash Adjuster
22. Spring Thrust Washer
23. Lash Adjuster Spring
24. Pitman Shaft
25. Steering Gear Housing
26. Pitman Shaft Needle Bearing
27. Single Lip Oil Seal
28. Inner Back-Up Washer
29. Double Lip Oil Seal
30. Outer Back-Up Washer
31. Retaining Ring
32. Ball Return Guide Retainer Screws
33. Ball Return Guide Retainer
34. Ball Return Guide
35. Rack - Piston Nut Balls
36. Rack - Piston Nut
37. Rack - Piston Nut Ring
38. Rack - Piston Nut Ring Back-Up Seal
39. Rack - Piston Nut End Plug
40. End Plug "O" Ring Seal
41. Housing Lower End Plug
42. Housing Lower End Plug Retainer

Fig. 9A-20 Power Steering Gear Assembly - Exploded View

cracked, pitted or broken, the entire rotary valve assembly should be replaced. A slight polishing on the valving surfaces is normal.

### INSPECTION OF GEAR HOUSING

1. Inspect gear housing for any defects in the piston bore or the rotary valve bore. Inspect all retaining ring grooves and seal surfaces for scratches or nicks. If any major defects are found, the housing should be replaced.

*NOTE: A slight polishing of the cylinder bore by the piston is not uncommon and does not affect the operation of the gear.*

2. Inspect ball plug in the housing, if leaking or raised above the housing surface, drive in flush to 1/16" below the surface. The ball plug can be tightened by staking the housing. The housing should be replaced only if leaks in this area cannot be properly sealed.

Clean area of leak with solvent and/or a wire brush. Dry thoroughly and apply a liquid sealant which will flow into the area between the ball plug and the housing and then harden. Devcon "B" or equivalent (commercially available products) should seal such leaks.

3. Inspect the connectors. If badly brinelled or scored, replacement will be necessary.

4. Inspect pitman shaft gear needle bearing; if worn or pitted, replace.

## SUB-ASSEMBLIES—ASSEMBLE

Lubricate all parts as they are assembled.

### ASSEMBLE PITMAN SHAFT GEAR AND SIDE COVER

1. Screw lash adjuster through side cover until cover bottoms on pitman shaft gear.

2. Install lash adjuster lock nut while holding lash adjuster with 7/32" allen wrench.

### ASSEMBLE ROTARY VALVE

1. Assemble one valve body Teflon ring back-up "O" ring seal in each groove on valve body. Do not allow seals to become twisted.

2. Assemble valve Teflon rings in ring grooves over the "O" ring seals by carefully slipping the rings over valve body. The rings may appear loose or twisted in the grooves, but the heat of the oil after assembly will cause them to straighten.

3. Install valve spool dampener "O" ring seal in valve spool groove, then lubricate seal in Type A hydraulic fluid. Do not allow seal to twist in the groove.

4. Assemble stub shaft assembly in valve body aligning the groove in the valve cap with pin in valve body (Fig. 9A-21). Press on cap until cap is against the shoulder in valve body with valve body pin in the cap groove. Hold these parts together during the rest of the assembly.

5. With notch end of spool towards valve body, install spool, aligning spool notch with pin in stub shaft.

*CAUTION: Because of the small clearance between the valve spool and valve body, extreme care must be taken when assembling these parts. Push the spool evenly and slowly with a slight oscillating motion until spool reaches drive pin. Before pushing spool completely in, make sure dampener "O" ring seal in evenly distributed in spool groove. Slowly push spool completely in, with extreme care taken not to cut or pinch the "O" ring seal.*

6. Slide spool spring over stub shaft and work the spring in position.

7. Lubricate cap to worm "O" ring seal and install in valve assembly.

*NOTE: If during the assembly of the valve the stub shaft and cap assembly is allowed to slip out of engagement with the valve body pin, the spool*

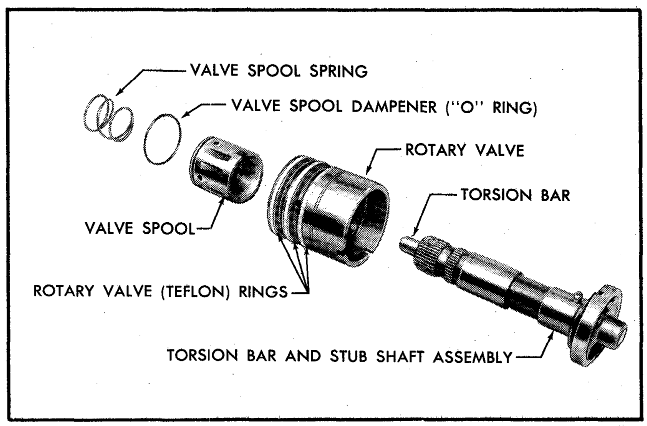



Fig. 9A-21 Rotary Valve - Exploded View

*will be permitted to enter valve body too far. The dampener "O" ring seal may expand into valve body oil grooves preventing removal of spool.*

a. Remove valve spool spring and disassemble rotary valve assembly.

b. Press on spool until the "O" ring seal is cut and spool can be removed.

c. Replace "O" ring seal and proceed with assembly as before.

### ASSEMBLE HOUSING

1. With stamped end of needle bearing against shoulder of adapter J-6278-3, use Remover and Replacer J-6278-1 to drive pitman shaft needle bearing into bore from outside of housing until flush-to-1/32" below shoulder. Make sure needle bearings rotate freely (Fig. 9A-22).

2. Lubricate the cavity between lips of pitman shaft (double lip) seal with high melting point, water resistant wheel bearing lubricant.

3. Lubricate and install pitman shaft seals; single lip seal, inner back-up washer, double lip seal, outer dust seal and retaining ring in housing bore (Fig. 9A-23). Use tool J-6219 (Fig. 9A-24) for seals and J-4245 for retaining ring. Make sure seal lips are properly positioned, retaining ring is seated, and that approximately 1/16" clearance is maintained between the inner seal (single lip) and the bearing.

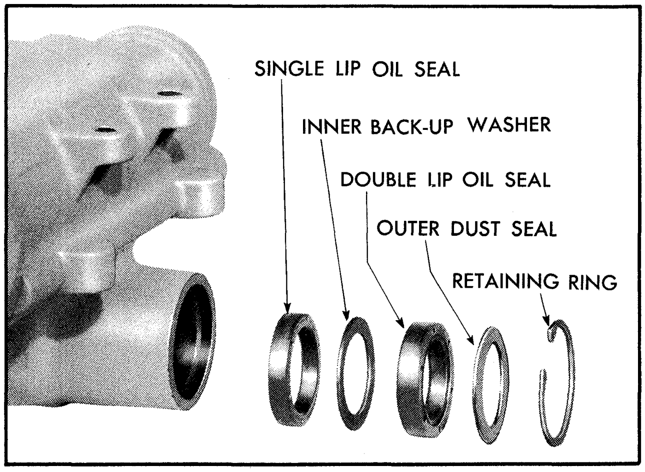



Fig. 9A-23 Pitman Shaft Seals and Washers

4. If connectors were removed, install new connectors by driving into place with tool J-6217 (Fig. 9A-25).

### ASSEMBLE RACK—PISTON NUT AND WORM

1. Lubricate and install new ring back-up seal and Teflon piston ring on rack-piston nut being careful ring and seal do not twist during installation.

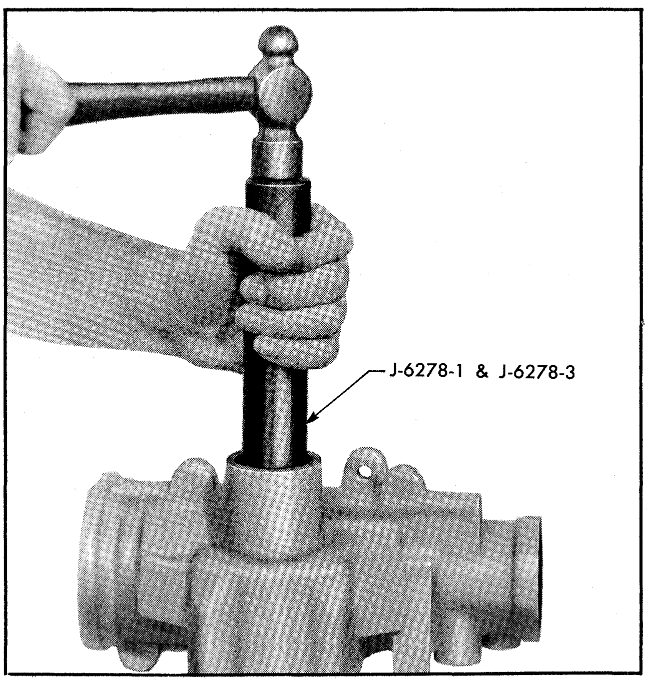



Fig. 9A-22 Installing Pitman Shaft Needle Bearing

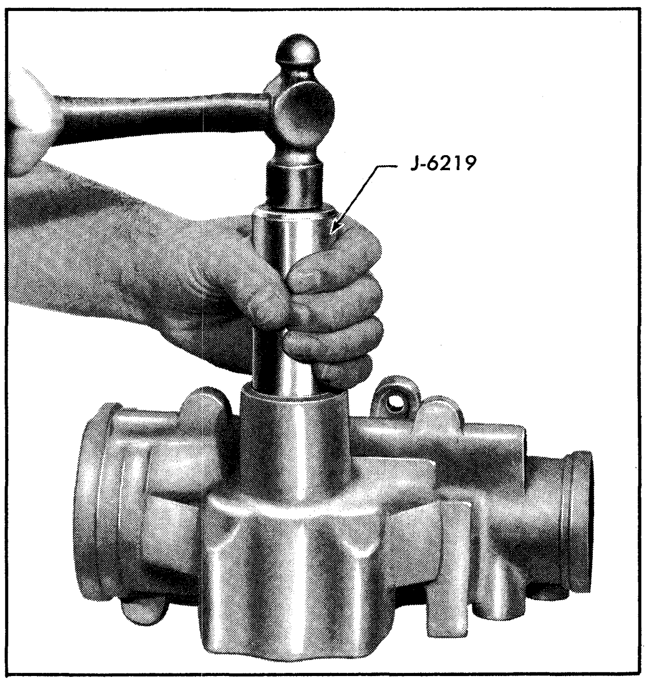



Fig. 9A-24 Installing Pitman Shaft Seals Using J-6219

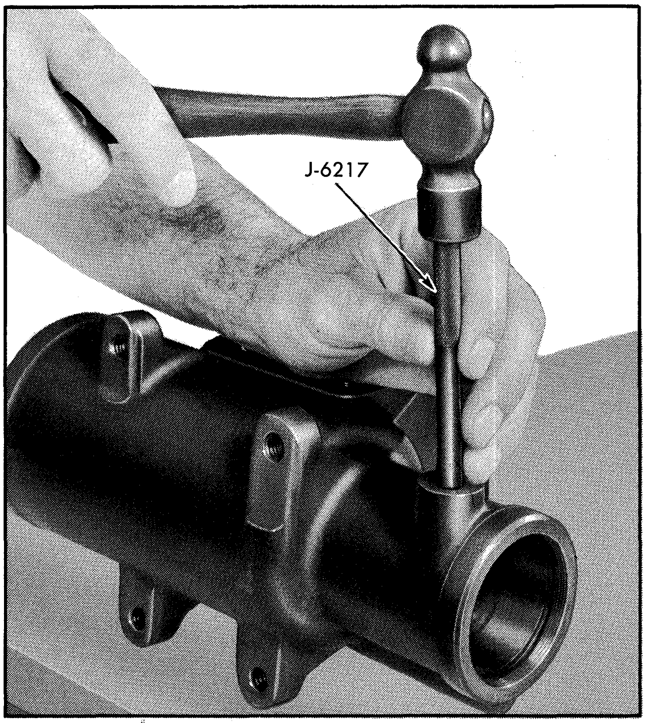



Fig. 9A-25 Installing Connector Using J-6217

2. Insert worm into rack-piston nut to bearing shoulder (Fig. 9A-26).

3. Align ball return guide holes with worm groove. Load 15 balls into the guide hole nearest the Teflon piston ring while slowly rotating worm to left feed balls through the circuit. Alternate black balls with the silver balls. If balls are installed properly the worm should turn out of rack-piston nut.

4. Fill one-half of ball return guide with the remaining 7 balls. Place the other guide over the balls and plug each end with heavy grease to prevent the balls from falling out when installing guides into rack-piston nut (Fig. 9A-27).

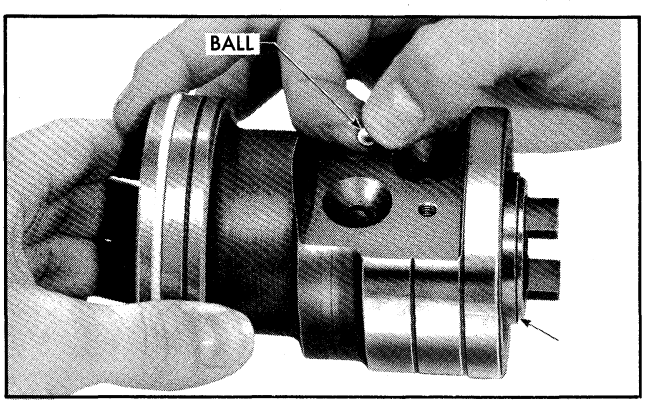



Fig. 9A-26 Loading Rack - Piston Nut

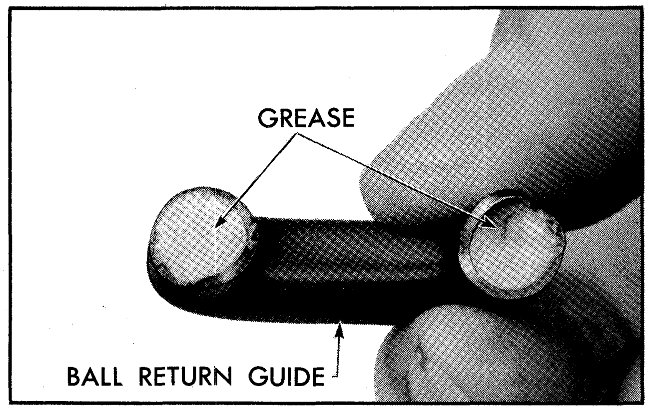



Fig. 9A-27 Ball Return Guide

5. Insert guides into guide holes of the rack-piston nut. Guides should fit loosely.

6. Place return guide clamp over guides and install two screw and lock washer assemblies and tighten to 8-12 lb. ft. torque.

### *CHECK WORM PRELOAD*

The worm groove is ground with a high point in the center. When the rack-piston nut passes over this high point, a preload of 0.5-3.0 lb. in. torque should be obtained.

*NOTE: DO NOT refit rack-piston balls unless a complaint of loose steering is received. Upon such a complaint, a thrust adjustment and over center adjustment should correct the problem if it lies in the steering gear.*

1. With worm pointing up, lightly clamp rack-piston nut in a bench vise having brass jaws.

*CAUTION: Do not hold rack-piston nut in area of Teflon ring.*

2. Place valve assembly on worm, engaging worm drive pin.

3. Rotate worm until it extends 1 1/4 inches from rack-piston nut to thrust bearing face. This is the center position.

4. Attach an inch-pound torque wrench with 3/4 inch 12-point socket to stub shaft (Fig. 9A-28).

5. Oscillate wrench through a total arc of approximately 60 degrees in both directions several times and take a reading. The highest reading obtained with worm rotating should be between 0.5 to 3.0 lb. in. torque. Record torque when in specifications.

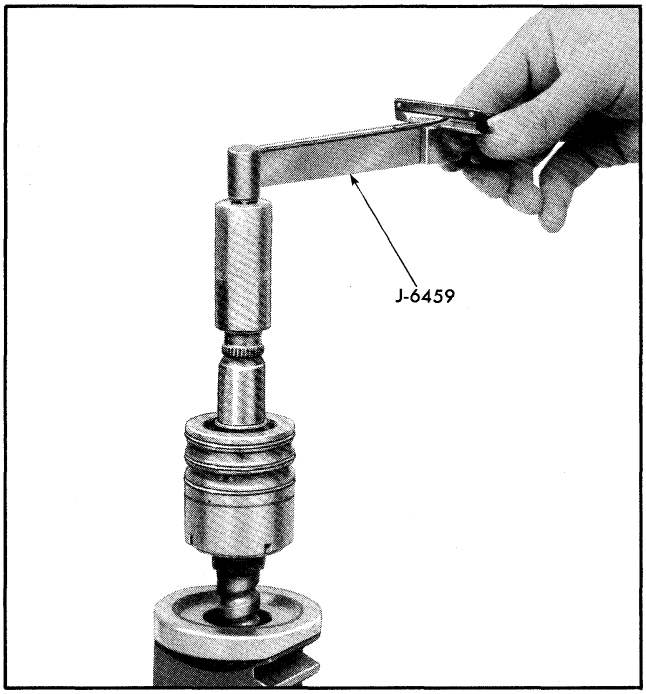



Fig. 9A-28 Checking Worm Preload

*NOTE: DO NOT use a torque wrench having maximum torque reading of more than 100 lb. in. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one-half of this total as the average torque.*

*NOTE: DO NOT refit rack-piston balls unless a complaint of loose steering is received. Upon such a complaint, a thrust adjustment and over center adjustment should correct the problem if it lies in the steering gear. If balls were pitted or rough then select the proper ball size for proper adjustment.*

6. If the reading is too high or low (on new balls only), disassemble and reassemble using next size smaller (or larger) balls and recheck.

Table of Selective Sizes of
Steering Nut Balls

| | | |
|---|---|---|
| 6 | .28117" | 5685706 |
| 7 | .28125" | 5685707 |
| 8 | .28133" | 5685708 |
| 9 | .28141" | 5685709 |
| 10 | .28149" | 5685710 |
| 11 | .28157" | 5685711 |

A rack-piston nut with a ball size of 7 does not have a number stamped on the flat surface. For ball sizes other than No. 7 the ball size is stamped on the flat surface of the rack-piston nut. In order to obtain proper worm bearing preload install the proper new balls.

7. Remove rotary valve assembly from worm head.

8. Position arbor (tool J-7539) against worm end. Turn worm out of rack-piston assembly following worm end with arbor. Do not allow arbor to separate from worm until rack-piston nut is fully on the arbor. The arbor now keeps the balls from dropping out of the ball nut.

### *ASSEMBLE WORM SHAFT, ROTARY VALVE ASSEMBLY AND ADJUSTER PLUG AS AN ASSEMBLY*

1. Assemble lower thrust bearing and races on worm (Fig. 9A-29).

2. Be sure "O" ring seal is between valve body and worm head and assemble valve assembly to worm by aligning slot in valve body with pin on worm head.

3. Install new "O" ring on adjuster plug.

4. Install adjuster plug assembly on stub shaft so bearing rests against upper bearing assembly.

## STEERING GEAR—ASSEMBLE

### *ADJUST THRUST BEARING PRELOAD*

1. Install worm valve assembly and adjuster plug in housing as integral unit.

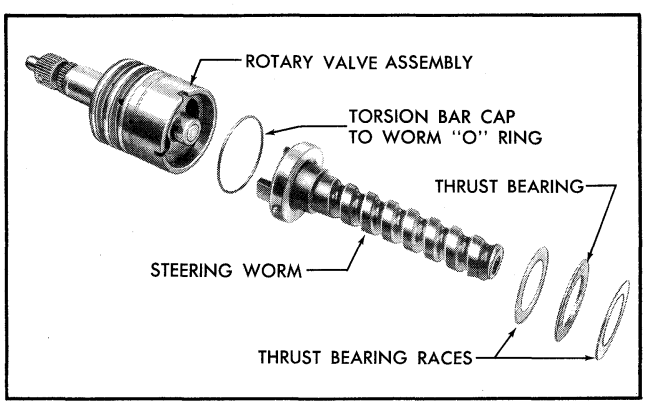



Fig. 9A-29 Worm Shaft and Rotary Valve - Exploded View

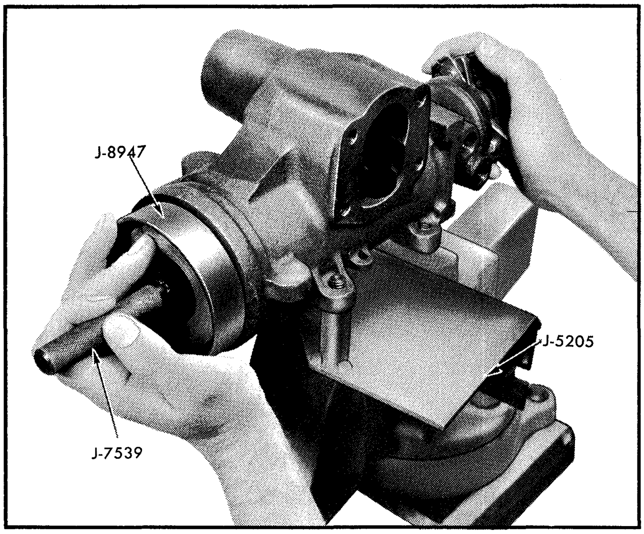



Fig. 9A-30 Installing Rack - Piston Nut

2. Tighten adjuster plug snug in gear housing and back off slightly (1/8 turn maximum.)

3. With torque wrench on stub shaft read torque required to rotate worm, valve assembly, and stub shaft in housing (drag).

4. Turn adjuster plug in until torque reading increased 0.5-3.0 lb. in. above drag reading obtained in (3) above.

*NOTE: Do not use a torque wrench having maximum torque reading of more than 100 lb. in. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one half of this total as the average torque.*

5. Install adjuster plug lock nut and tighten to 50-110 lb. ft. torque.

6. Recheck thrust bearing preload. Total thrust bearing adjustment plus drag should not exceed 7 lb. in. torque.

### REPLACE RACK-PISTON

1. Slip stub shaft flange onto end of stub shaft.

2. Holding Teflon ring compressor sleeve tool J-8947 tightly against the shoulder of gear housing insert the rack-piston nut and arbor into housing holding the arbor (tool J-7539) until arbor contacts worm end. See Fig. 9A-30.

3. Holding the arbor tight against the worm, turn stub shaft flange (and worm) to draw ball nut onto worm and into housing until the arbor is free.

*CAUTION: Be certain that no balls drop out.*

4. Remove arbor and sleeve.

### REPLACE PITMAN SHAFT GEAR AND SIDE COVER

1. Turn steering worm until center groove of rack-piston is aligned with center of pitman shaft needle bearing.

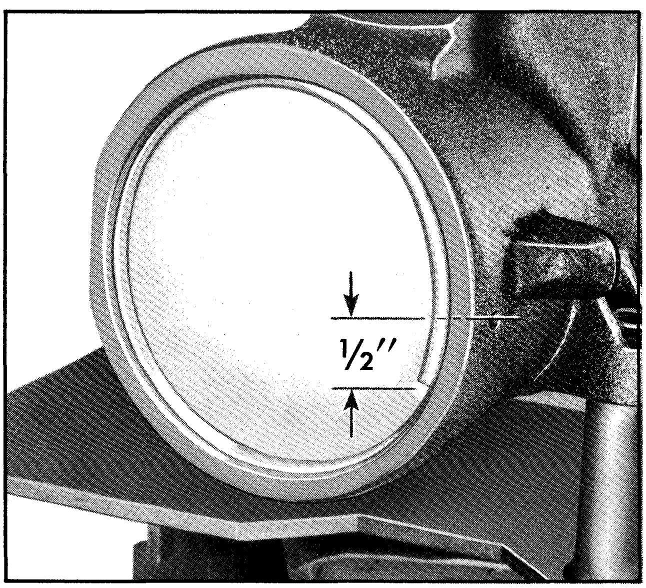



Fig. 9A-31 Installing End Plug Retainer Ring

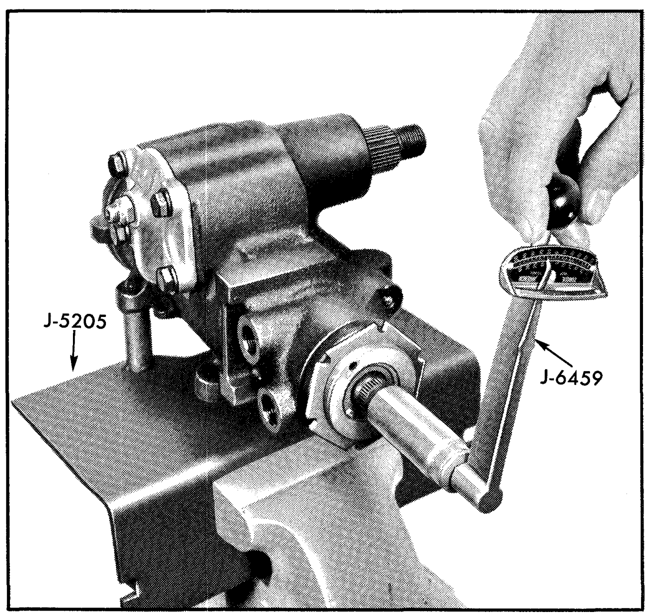



Fig. 9A-32 Adjusting Pitman Shaft Preload

2. Install new side cover "O" ring seal.

3. Install pitman shaft gear so that the center tooth of gear meshes with the center groove of rack-piston. Make sure that side cover "O" ring seal is in place before pushing cover against housing.

4. Install side cover screws and tighten to 25 to 35 lb. ft. torque.

5. Install end plug in rack-piston nut using 1/2" square drive and tighten to 50-100 lb. ft. torque.

## REPLACE HOUSING LOWER END PLUG

1. Install new housing end plug "O" ring seal.

2. Insert end plug into gear housing and seat against "O" ring seal. Slight pressure may be necessary to seat end plug properly.

3. Install end plug retainer ring so end of ring extends over and at least 1/2" beyond the ring removal assist hole (Fig. 9A-31).

## ADJUST PITMAN SHAFT PRELOAD THROUGH CENTER HIGH POINT

*NOTE: DO NOT use a torque wrench having maximum torque reading of more than 100 lb. in. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one half of this total as the average torque.*

Using a 3/4"-12 point deep socket and inch-pound torque wrench, (Fig. 9A-32) take a reading through the center position to determine total drag, thrust bearing adjustment, and rack and worm preload. Adjust lash adjuster so torque is between 3 and 6 lb. in. in excess of the total reading found above.

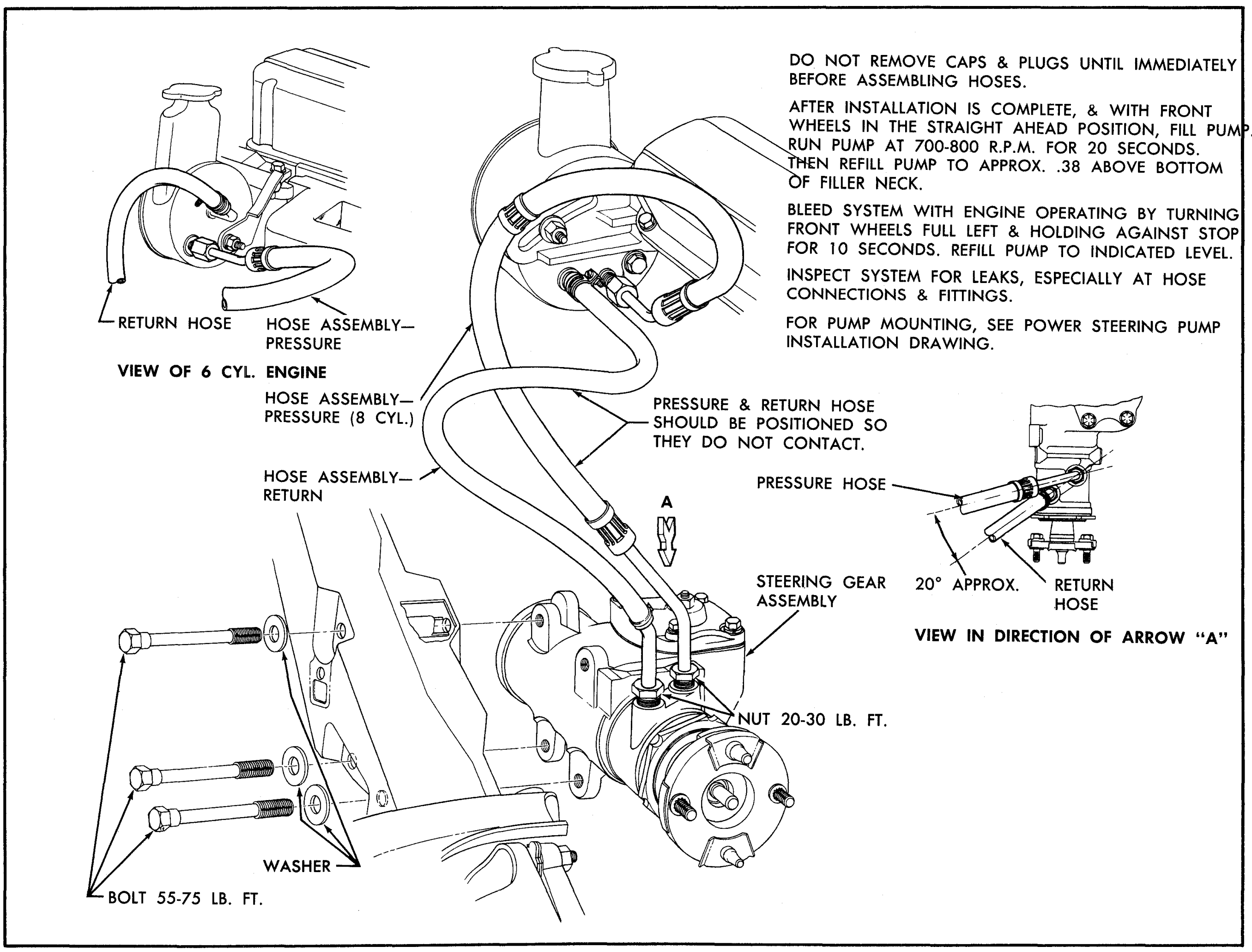



Fig. 9A-33 Installation of Power Steering Gear Assembly

Total over center preload must not exceed 14 lb. in. through center high point when rotating worm shaft through an arc of approximately 20°. Tighten lash adjuster nut to 20-30 lb. ft. torque. Recheck preload after nut has been tightened.

### REPLACE STUB SHAFT FLANGE

1. Replace stub shaft flange, aligning the flat surface on the stub shaft serrations with the flat section in the flange hole.

2. Install flange clamping bolt and tighten to 25 to 35 lb. ft. Be sure to position flange so that it clears the end of the adjuster plug by approximately 1/16 inch and rotates without interference with the adjuster plug.

## STEERING GEAR—INSTALL

1. Position steering gear assembly in car aligning large head rivet in widest upper flange opening.

*NOTE: If same gear housing is replaced, locate any 1/8" standard washer shims that were removed in their original position between housing and frame. If steering gear has new housing or requires any alignment, flat washers of appropriate thickness and diameter should be selected for proper alignment of steering gear and steering column assembly. Metal to metal contact between flanges on stub shaft assembly and steering shaft assembly will transmit and amplify gear noise to the driver.*

2. Install steering housing to frame bolts finger tight. Shift gear assembly to obtain best alignment with flange on steering shaft. Tighten housing to frame bolts to 55-75 lb. ft. torque.

3. Install pitman arm and secure with lock washer and nut. Tighten nut to 110-140 lb. ft. torque.

4. Connect pressure and return hose assemblies to gear assembly and tighten to 20-30 lb. ft. torque.

5. Install two flange flexible coupling attaching nuts and lock washers and tighten to 15-20 lb. ft. torque.

6. Check fluid level in pump reservoir. Fluid should be up to oil level mark in reservoir. Add Automatic Transmission Fluid Type A identified by an AQ-ATF qualification number as necessary. With front wheels off floor start engine and bleed hydraulic system by manually steering through cycle several times until there is no evidence of air bubbles in reservoir. Recheck fluid level and lower car.

## POWER STEERING GEAR TROUBLE DIAGNOSIS

| CONDITION | CAUSE | REMEDY |
|---|---|---|
| 1. Hard steering while driving | Frozen steering shaft bearings | Replace bearings |
| | Lower coupling flange rubbing against adjuster | Loosen bolt and assemble properly |
| | Steering wheel rubbing against gearshift bowl | Adjust jacket endwise |
| | Steering adjustment tight | Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball. Readjust if necessary |
| 2. Poor return of steering | Frozen steering shaft bearings | Replace bearings |
| | Lower coupling flange rubbing against adjuster | Loosen bolt and assemble properly |
| | Steering wheel rubbing against gearshift bowl | Adjust jacket endwise |

| CONDITION | CAUSE | REMEDY |
|---|---|---|
| 2. Poor return of steering cont'd. | Tires not properly inflated | Inflate to specification |
| | Incorrect caster or toe-in front wheels | Adjust to specification |
| | Tight steering linkage | Lubricate-check end plugs |
| | Steering gear misalignment | Re-shim at frame |
| | Tightness of suspension ball joints | Lubricate or otherwise free up |
| | Steering adjustment tight | Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball. Readjust if necessary |
| | Tight sector to rack-piston adjustment | Adjust in car to specification |
| | Thrust bearing adjustment too tight | Remove gear and adjust to specification |
| | Rack-piston-nut and worm preload too tight | Remove gear and replace balls as required |
| | Sticky valve spool | Remove and clean valve or replace valve |
| 3. Car leads to one side or the other | Due to front end misalignment | Adjust to specification |
| | Unbalanced or badly worn valve<br>*NOTE: If this is cause, steering effort will be very light in direction of lead and heavy in opposite direction.* | Replace valve |
| 4. Momentary increase in effort when turning wheel fast to the right | Low oil level in pump | Check oil level in pump reservoir |
| | Pump belt slipping | Tighten or replace belt |
| | High internal leakage | Replace rack-piston nut piston ring, ring back-up seal and/or replace valve |
| 5. Momentary increase in effort when turning wheel fast to the left | Low oil level in pump | Check oil level in pump reservoir |
| | Pump belt slipping | Tighten or replace belt |
| | High internal leakage | Replace rack-piston nut piston ring, ring back-up seal, valve body to worm seal and/or replace valve |

| CONDITION | CAUSE | REMEDY |
|---|---|---|
| 6. External oil leaks (wipe gear thoroughly and make sure source of leakage is determined) | Loose hose connections | Tighten |
| | Damaged hose | Replace |
| | Side cover "O"-ring seal | Replace seal |
| | Pitman shaft seals | Replace seals |
| | Housing end plug seal | Replace seal |
| | Adjuster plug seals | Replace seals |
| | Torsion bar seals | Replace rotary valve assembly |
| 7. Gear noise (rattle or chuckle). | Loose over-center adjustment<br>*NOTE: A slight rattle may occur on turns because of the increased lash off the "high point". This is normal and the lash must not be reduced below the specified limits to eliminate this slight rattle.* | Adjust to specification |
| 8. Gear noise ("hissing" sound). | Gear loose on frame | Check gear-to-frame mounting bolts. Tighten bolts to specifications. |
| | There is some noise in all power steering systems. One of the most common is a "hissing" sound most evident at standstill parking. There is no relationship between this noise and performance of the steering. Hiss may be expected when steering wheel is at end of travel or when slowly turning at standstill. | Do not replace valve unless "hiss" is extremely objectionable. Slight hiss is satisfactory and in no way affects steering. A replacement valve may also exhibit slight noise and is not always a cure for the objection. Be sure steering shaft and gear are aligned so the flexible coupling rotates in a flat plane and is not distorted as shaft rotates. Any metal to metal contact through the flexible coupling will transmit the valve hiss into the car. |
| 9. Excessive wheel kickback or loose steering. | Lash in steering linkage | Adjust parts affected |
| | Air in system | Add oil to pump reservoir and bleed system of air |
| | Excessive lash between pitman shaft sector and rack-piston | Adjust to specification |
| | Loose thrust bearing adjustment | Remove gear and adjust to specification |

| CONDITION | CAUSE | REMEDY |
|---|---|---|
| 9. Excessive wheel kickback or loose steering (cont'd.) | Ball nut and worm preload | Check thrust bearing adjustment and over center adjustment. Check for looseness in steering linkage. If complaint still exists, remove rack-piston and worm, and change balls to obtain specified preload. |
| | Ball Joints loose | See Ball Joints under FRONT SUSPENSION |
| | Front wheel bearings incorrectly adjusted or worn | Adjust or replace front wheel bearings |
| 10. Steering wheel surges or jerks when turning with engine running, especially during parking. | Loose pump belt | Adjust to specification |
| 11. Hard Steering when parking. | Loose pump belt | Adjust to specification |
| | Low oil level in reservoir | Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage |
| | Lack of lubrication in linkage or front suspension | Add lubricant where needed |
| | Tires not properly inflated | Inflate to recommended pressure |
| | Insufficient oil pressure | If all of the above checks do not reveal the cause of hard steering, make the following tests of oil pressure:<br>1. Disconnect the pressure line at oil pump. Attach gauge to pump. Connect the hose to end of gauge where the valve is located.<br>2. With engine at warm idle and gauge valve open, note the oil pressure on the gauge while turning steering wheel from one extreme position to the other. Especially note the maximum pressure which can be built up with the wheel held in either right or left extreme position. |

| CONDITION | CAUSE | REMEDY |
| --- | --- | --- |
| 11. Hard Steering when parking (cont'd.) | Insufficient oil pressure (cont'd.) | *CAUTION: Do not hold wheel in extreme position for an extended period of time because it will drastically increase the oil temperature and will cause undue wear on the oil pump.* |

3. With oil temperature between 150°F and 170°F, as measured with a thermometer in the reservoir, the maximum oil pressure should not be less than 925 psi for satisfactory power steering operation.

4. If the maximum oil pressure is less than 925 psi, it indicates trouble in the pump, oil hoses, steering gear, or a combination of these parts. To eliminate the hoses and gear, close the gauge valve and quickly test pressure of the pump only with the engine at warm idle, then open the valve to avoid increasing oil temperature.

5. Comparing the maximum pressures obtained in these two tests will indicate source of trouble as follows:

   a. First test (Step 2) pressure low, and second test (Step 4) pressure normal - indicates faulty external oil lines or steering gear.

   b. First test (Step 2) and second test (step 4) pressures equally low - indicates faulty oil pump,

If above test shows trouble to be in pump, see pump section.

If trouble is shown to be in steering gear or hoses, examine for external oil leaks as under Condition No. 6.

| CONDITION | CAUSE | REMEDY |
|---|---|---|
| 11. Hard steering when parking (cont'd.) | Low oil pressure due to restriction in hoses: | |
| | a. Check for kinks in hoses | Remove kink |
| | b. Foreign object stuck in hose | Remove hoses and remove restricting object or replace hose |
| | Low oil pressure due to steering gear: | |
| | a. Pressure loss in cylinder due to worn piston ring, damaged ring back-up seal or scored housing bore | Remove gear from car for disassembly and inspection of ring, back-up seal and housing bore |
| | b. Leakage at valve rings and/or valve body to worm seal | Remove gear from car for disassembly and replace ring or seal |
| | c. Loose fit of spool in valve body or leaky valve body | Replace rotary valve assembly |
| | Loss of assist coming out of left turn: | Check oil level in pump reservoir |
| | | Tighten or replace belt |
| | | Replace rack-piston nut, piston ring and ring back-up seal. When the rack-piston nut is out, make sure there is a chamfer on both sides of the ring groove, otherwise replace nut with one having a chamfer on both sides of the ring groove |
| 12. Valve squawk when turning or when recovering from a turn. | Cut or worn dampener ring on valve spool | Replace dampener ring, being careful not to cut the new ring at installation |
| | Loose or worn rotary valve parts | Replace rotary valve assembly |
| 13. No effort required to turn. | Broken torsion bar | Replace rotary valve assembly |

## POWER STEERING GEAR SPECIFICATIONS

| | |
|---|---|
| Over All Steering Ratio | approx. 20.65 to 1 |
| Steering Gear Ratio | 17.5 to 1 |
| Steering Wheel Effort | |
| Normal Driving | 1 to 2 lbs. |
| Parking | 2 to 3.5 lbs. |
| Torque | |
| Adjuster Plug Lock Nut | 50-110 lb. ft. |
| Lower Flange Attaching Bolt | 25-35 lb. ft. |
| Pitman Arm Lock Nut | 110-140 lb. ft. |
| Pitman Shaft Preload Lash Adjuster Lock Nut | 20-30 lb. ft. |
| Pressure Hose Connector at Gear | 20-30 lb. ft. |
| Rack-Piston Nut End Plug | 50-100 lb. ft. |
| Return Hose Connector at Gear | 20-30 lb. ft. |
| Side Cover Screws | 25-35 lb. ft. |
| Steering Gear Housing to Frame Bolts | 55-75 lb. ft. |
| Power Steering System Fluid Capacity | 2.5 Pints |

# POWER STEERING VANE TYPE PUMP

## CONTENTS OF THIS SECTION



## GENERAL DESCRIPTION

The power steering pump has an outlet capacity of (L-6) 1.25 gal. per min., (V-8) 1.75 gal. per min. at idle. It is mounted on the engine and driven by a belt from the crankshaft harmonic balancer.

The component parts of the power steering pump are encased in a reservoir, Fig. 9A-34, filled with oil used for the power steering gear. The reservoir has a filler neck with a vented cap and is fastened to the pump housing leaving only the housing face and shaft hub exposed.

A pump housing within the reservoir houses a babbitt bushing and a shaft seal, and has two openings from the rear side. The larger of these openings has two dowel pins in the pump inner face that hold the functional parts of the pump: the thrust plate, rotor ring (which contains the rotor and vanes) and the pressure plate. The smaller opening houses a flow control valve and spring.

### THRUST PLATE

The thrust plate is located adjacent to the inner face of the pump housing. One side of the thrust plate performs the function of taking the rearward shaft thrust. The other side consists of six crescent or kidney shaped cavities and two openings at the plate sides and opposite each other (Fig. 9A-35).

Four of the crescent shaped cavities are located around the drive shaft hole (but are not connected with each other) and are for undervane oil pressure. The other two cavities are for discharging the oil under pressure into a high pressure area that provides oil for the gear. These two cavities are in line with the two crossover holes in the pump ring which feed high pressure (discharging) oil through the pressure plate into the high pressure area to provide oil requirements as called for by the steering gear.

The two openings diametrically opposite from each other, are for intake of oil from the suction part of the pump.

### PUMP RING

The pump ring is a flat plate with a cam surface center opening. This ring encompasses the rotor and vanes and is located adjacent to the face of the thrust plate on the same two dowel pins that retain the thrust plate. The rotor is loosely splined to the pump drive shaft and turns with the shaft. Ten slots for vanes are evenly spaced around the rotor and extend from the rotor outer diameter inward to the center approximately 13/32" deep.

### PRESSURE PLATE

The pressure plate contains six holes that extend through the plate and two cavities. Four of the holes around the drive shaft hole are connected to high pressure oil. This oil is used to supply oil pressure to the vanes to insure their following the cam surface in the pump ring. The other two holes are for discharging the oil under pressure to the high pressure area for gear use.

The two cavities are radially open to the suction part of the pump and intake oil flows through these openings.

### RESERVOIR

The reservoir is an oil storage space and provides a means of directing the return oil back to the pump.

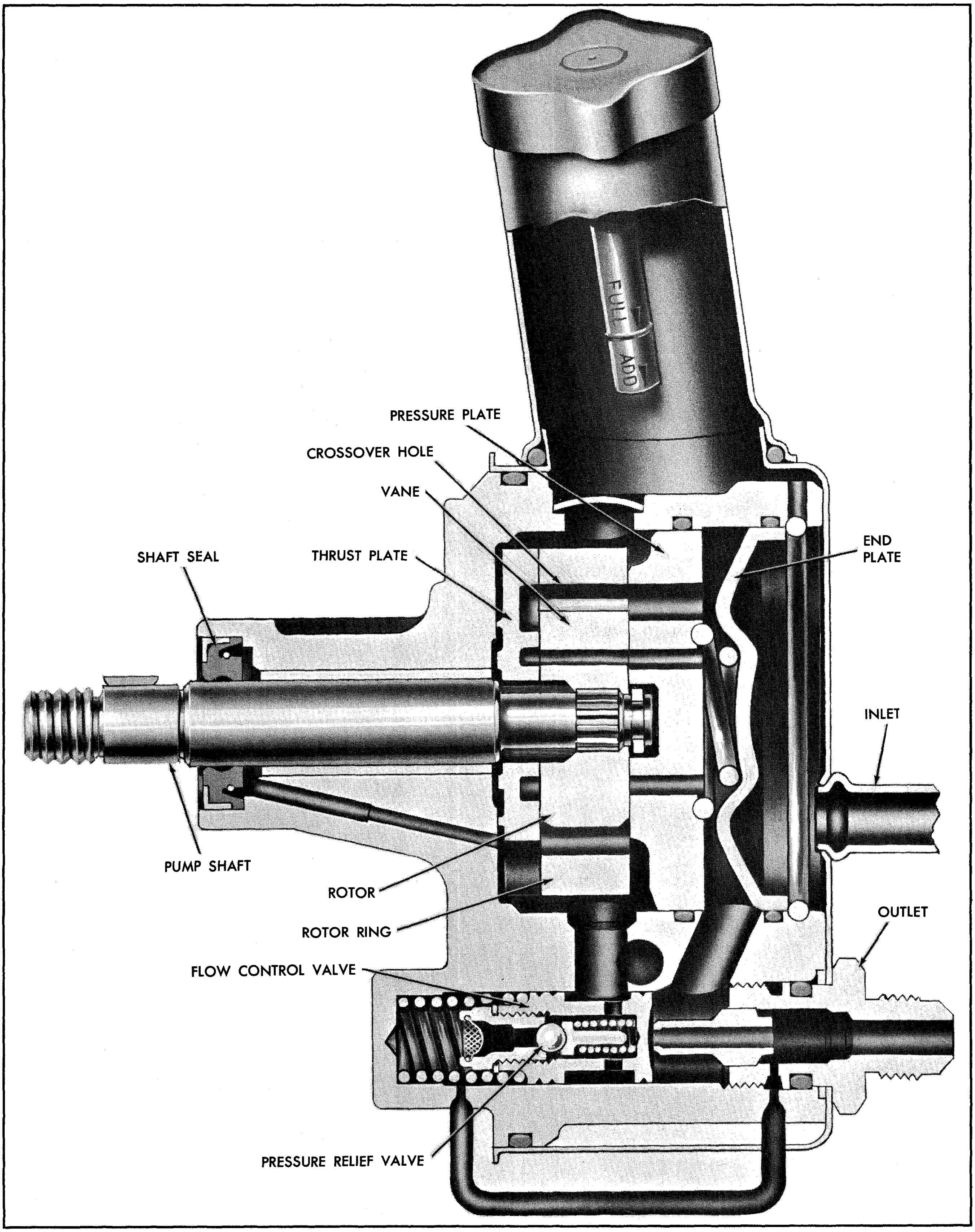



Fig. 9A-34 Power Steering Pump

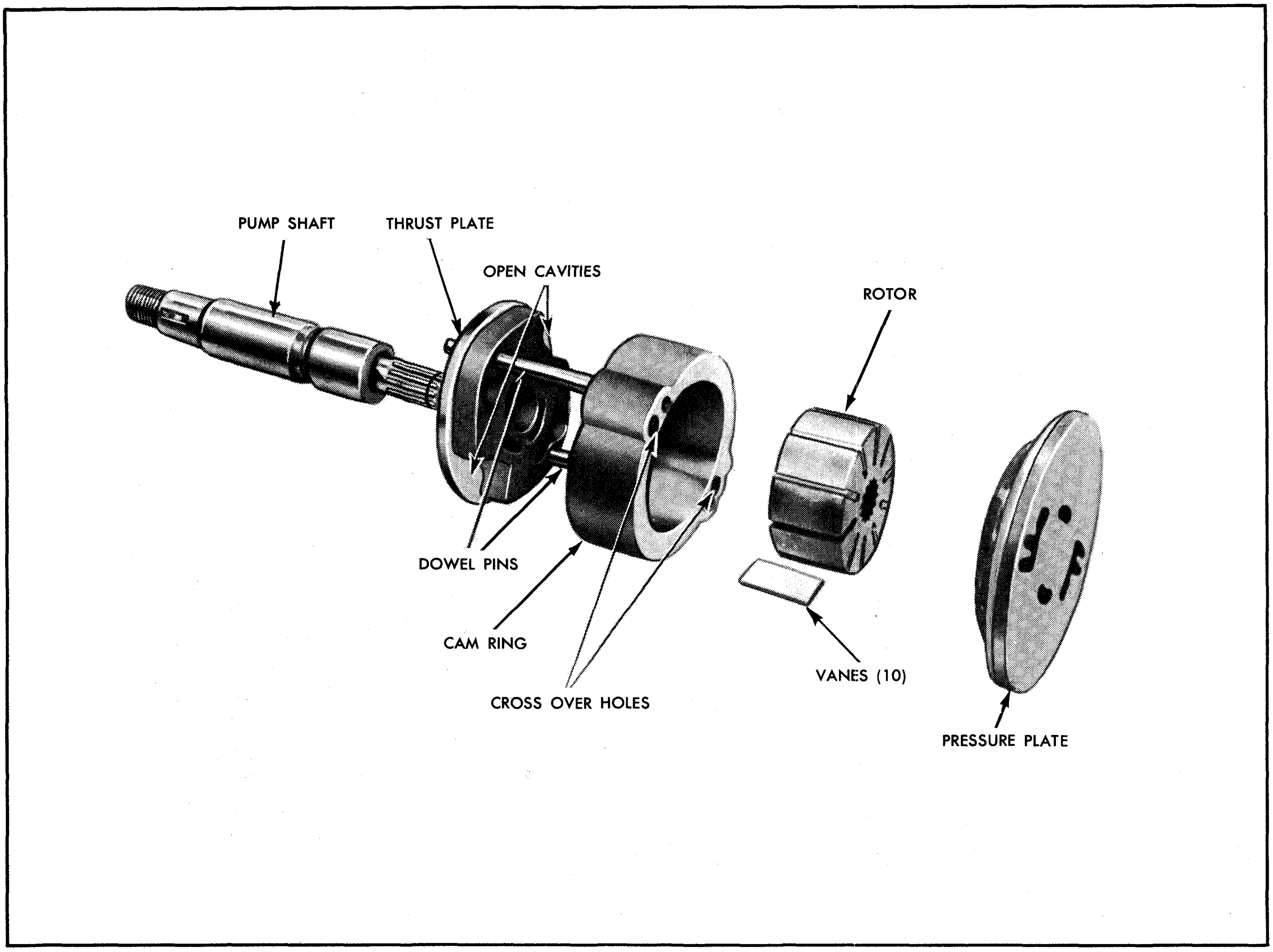



Fig. 9A-35 Power Steering Pump Components

### *DRIVE SHAFT*

The pump drive shaft is belt-driven by the crankshaft harmonic balancer and extends through all the major parts mentioned above except the pressure plate. The pump shaft rotates at a pump to engine ratio of 1.24.

### *FLOW CONTROL VALVE*

The purpose of the flow control valve is to control power steering system pressures and thereby oil flow to the gear as required under various operating conditions.

This valve assembly consists of a plunger, plunger screw, ball check, ball check guide and ball check guide spring. A screen in the end of the plunger screw is designed to keep dirt and foreign material out of the ball check area. Selective shims are used between the plunger screw and the valve plunger as required to calibrate the flow control valve assembly (with proper pressure in the ball check valve guide spring) to permit proper relief of pressure within the pump under high pump pressure operation.

Due to selective parts controlling calibration of this valve the flow control valve assembly is only serviced as an assembly.

## OPERATION

### *FILLING THE PUMP AND GEAR (Fig. 9A-36)*

When the pump and power steering gear are completely void of oil, adding oil to the reservoir will completely envelope the pump housing assembly which is inside the reservoir. Oil is drawn into the intake portion of the pump by suction (and weight of

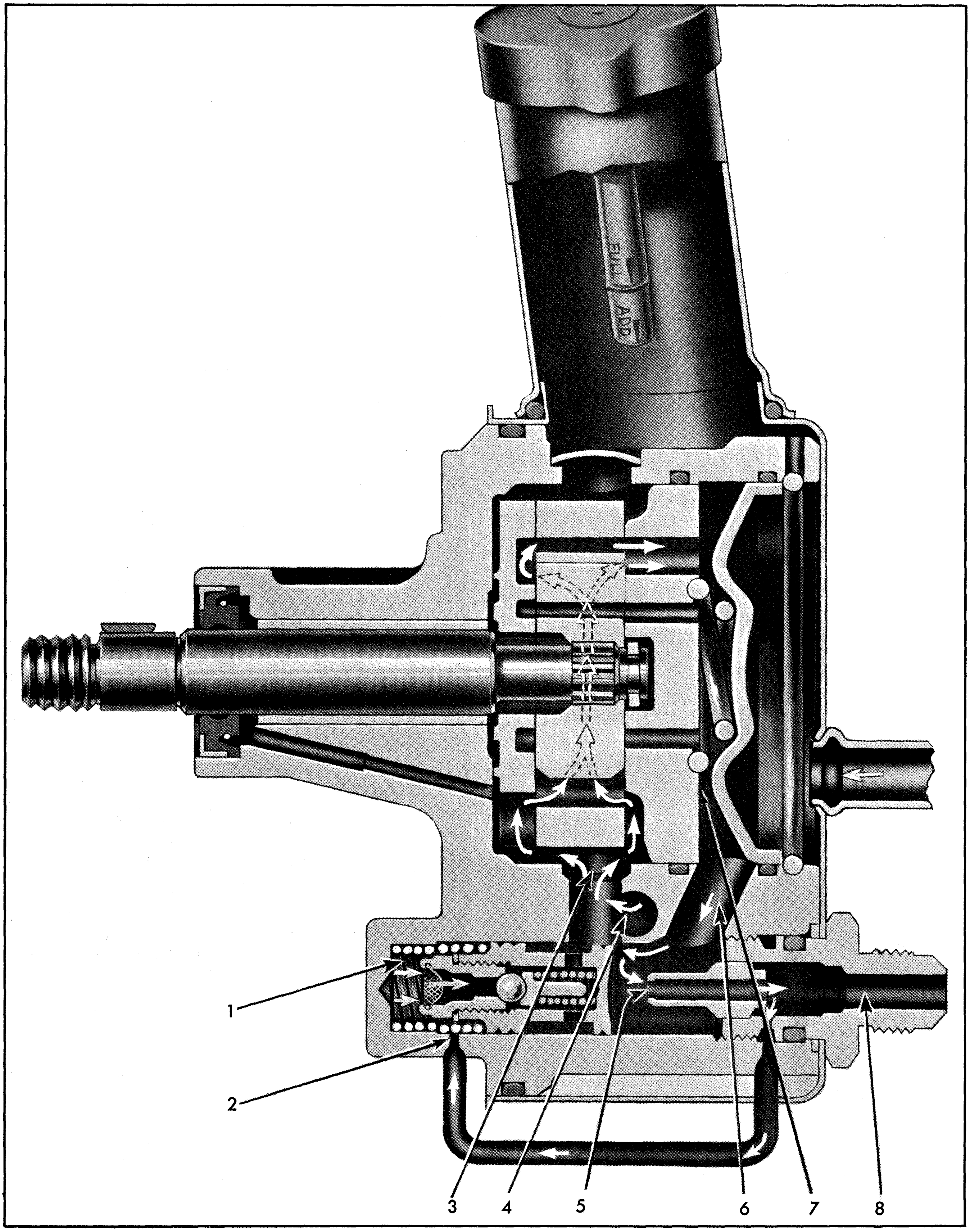



Fig. 9A-36 Oil Flow - Low Speed or Partial Turn

oil) causing it to flow through a drilled passage in the lower portion of the housing (4) to another drilled hole leading to a groove around the rotor ring (3) to tend to fill this area and also the two suction "openings" on the surface of the thrust plate and two suction openings in the pressure plate. Oil fills the lower opening in the thrust plate to feed the rising portion of the rotor ring. Air is pumped out of the pump through the gear oil circuit to the gear, then to return to the reservoir and out the vented cap.

As the rotor is splined to the drive shaft, it turns with the shaft and the vanes follow the cam surface machined in the pump ring. The cam is designed with two vane rising and two falling areas and, therefore, causes a complete pumping cycle to occur every 180 degrees of pump drive shaft rotation. Centrifugal force throws the vanes against the ring to pick up a little oil to be forced into the high pressure area.

Some oil will leak along the pump drive shaft to the shaft seal and to the area behind the thrust plate (via drilled passages in the housing). Leakage oil past the shaft is intended for lubrication of the shaft. The bleed passage to the area behind the thrust plate prevents pressure build up on the shaft seal.

As more and more oil is picked up by the vanes, more oil will be forced into the cavities of the thrust plate and then to flow through the two crossover holes in the rotor ring and the pressure plate, only to empty into the high pressure area of the pump between the pressure plate and the housing end plate (7).

As the high pressure area fills (7), some oil flows under the vanes through fully open crescent shaped slots in the pressure plate while the vanes are rising to force them to follow the cam surface of the rotor ring. The two holes drilled through the crescent shaped slots in the pressure plate are intended to restrict oil as it is forced out from under the vanes when they are falling.

When the flow controlling rotary valve in the steering gear is in the "neutral" or straight ahead, oil flows from the pump through the open center rotary valve in the gear and back to the pump reservoir without traveling through the power cylinder of the gear. At engine idle, or slightly below, the flow control valve remains closed or nearly so, because pump output is not high enough nor is oil pressure in the pump high enough to overcome the control valve spring to open the flow control valve.

When engine speed is increased, pump output and oil pressure is also increased and the flow of oil exceeds the predetermined power steering requirements. Therefore, the increase in oil pressure overcomes opposing pressure of the control valve spring to open the valve farther, which in turn lowers system pressure and also limits temperature rise in the system.

With the increase in engine rpm, oil pressure is more than adequate to supply the system requirements and overcome the force of the flow control valve spring. This allows the valve to open and direct oil to a by-pass hole thereby diverting oil into the pump intake chamber and oil is by-passed within the pump. The by-passing of this oil is of a high velocity discharging past the valve into the intake chamber and picks up make-up oil from the reservoir on the jet pump principle. During the straight ahead position, pressure should not exceed approximately 100 psi.

#### *FLOW CONTROL VALVE PRESSURE RELIEF*

When the steering gear rotary valve assembly is positioned such that it is fully actuated in either direction, the flow of oil from the pump is blocked or restricted for a quick return to the pump. (This condition would occur against the wheel stops or when movement of the wheels is restricted resulting in higher system pressures.)

In order to keep pressures and temperatures at a minimum, the pressure relief ball check is forced off its seat allowing a small amount of oil to flow into the intake chamber. This flow of oil, passing through the valve plunger screw and the flow control valve pressure relief orifice, causes a pressure drop and resulting lower pressure at the lower end of the control valve to provide additional control of the excessive pressure in the system under these conditions. Relief pressure under maximum conditions will control between 900 and 1000 psi, depending upon volume requirements.

The flow control valve, therefore, is designed to control the power steering pump oil flow capacity to the gear under various operating conditions. At idle speed the valve is closed and opens just above idle speed. It remains open in varying degrees depending upon engine speed, and system pressures under various operating conditions. As the system requirements approach or exceed maximum pressure within the system, the ball check within the flow control valve opens to provide additional relief of pressure and oil flow to the gear.

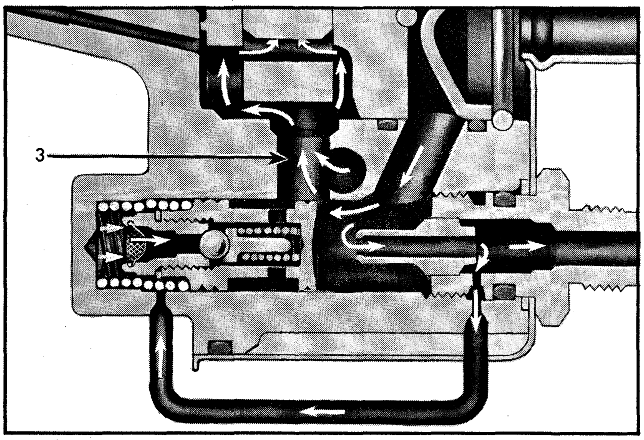



Fig. 9A-37 Oil Flow - High Speed, No Turn, Straight Ahead

*OIL FLOW—LOW SPEED OR PARTIAL TURN (Fig. 9A-36)*

From the high pressure chamber, the oil flows through a drilled passage (6) leading to a passage drilled through the outlet union (5). Oil is directed to the control valve through this outlet union (8). The outlet union passage also connects to the area that houses the flow control valve spring. The connecting passage is drilled in the housing and is directed to a pressure sensing orifice (2) which leads to the spring chamber behind the flow control valve (1).

When the quantity of oil displaced by the pump exceeds the predetermined steering system requirements a pressure drop occurs and oil flows through the outlet union passage. This pressure drop is communicated to the flow control valve spring chamber. With this pressure opposing the high pressure on the face of the flow control valve and outlet union, the valve opens slightly to provide oil pressure control or relief. The external surface still allows some oil to flow through the system.

*OIL FLOW—HIGH SPEED, NO TURN, STRAIGHT AHEAD (Fig. 9A-37)*

When operating at moderate and high speeds it is desirable to keep oil flow to a minimum in order to limit temperature rise. Therefore, the flow control valve opens wider (due to increased oil pressure) to allow more oil to be by-passed within the pump.

The pressure unbalance between the valve spring chamber and the outlet union increases as the engine speed increases. The greater pressure on the outlet union side then pushes the flow control valve back further to open the by-pass hole wider, thereby diverting more oil into the intake chamber (3). Supercharging of the intake chamber occurs under these conditions. Oil at high velocity discharging past the valve into the intake chamber picks up make-up oil from the reservoir on the jet pump principle. Then by reduction of velocity, velocity energy is converted into supercharge pressure.

*OIL FLOW—TURN AGAINST RESISTANCE (Fig. 9A-38)*

During a turn, resistance is offered to the pitman shaft and rack-piston nut, and extends to the pump high pressure chamber. It also extends through the pressure sensing orifice to the flow control valve spring chamber. Pressure in the chamber continues to build up until it overcomes the opposing spring pressure on the ball check in the flow control valve. If this pressure is slight, the ball check is sufficient to bleed off any excess pressure.

When the pressure is high, the flow control valve spring chamber pressure reduces below the opposing high pressure on the face of the outlet union and flow control valve plunger. The valve opens wide to provide oil pressure control for the gear. Oil flows through the passage leading to the suction or intake part of the pump.

Supercharging occurs when pressure oil in the area around the outlet union and flow control valve plunger discharges into the suction passage at high velocity.

## PERIODIC SERVICE RECOMMENDATIONS

No periodic service of the pump is required except checking oil level in reservoir as outlined in GENERAL LUBRICATION Section.

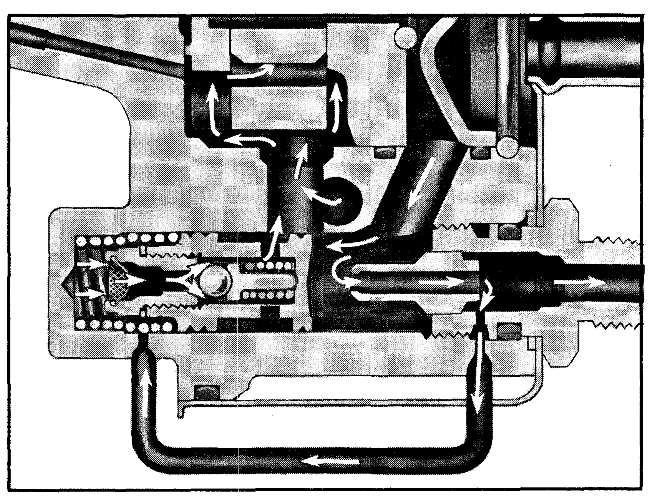


Fig. 9A-38 Oil Flow - Turn Against Resistance

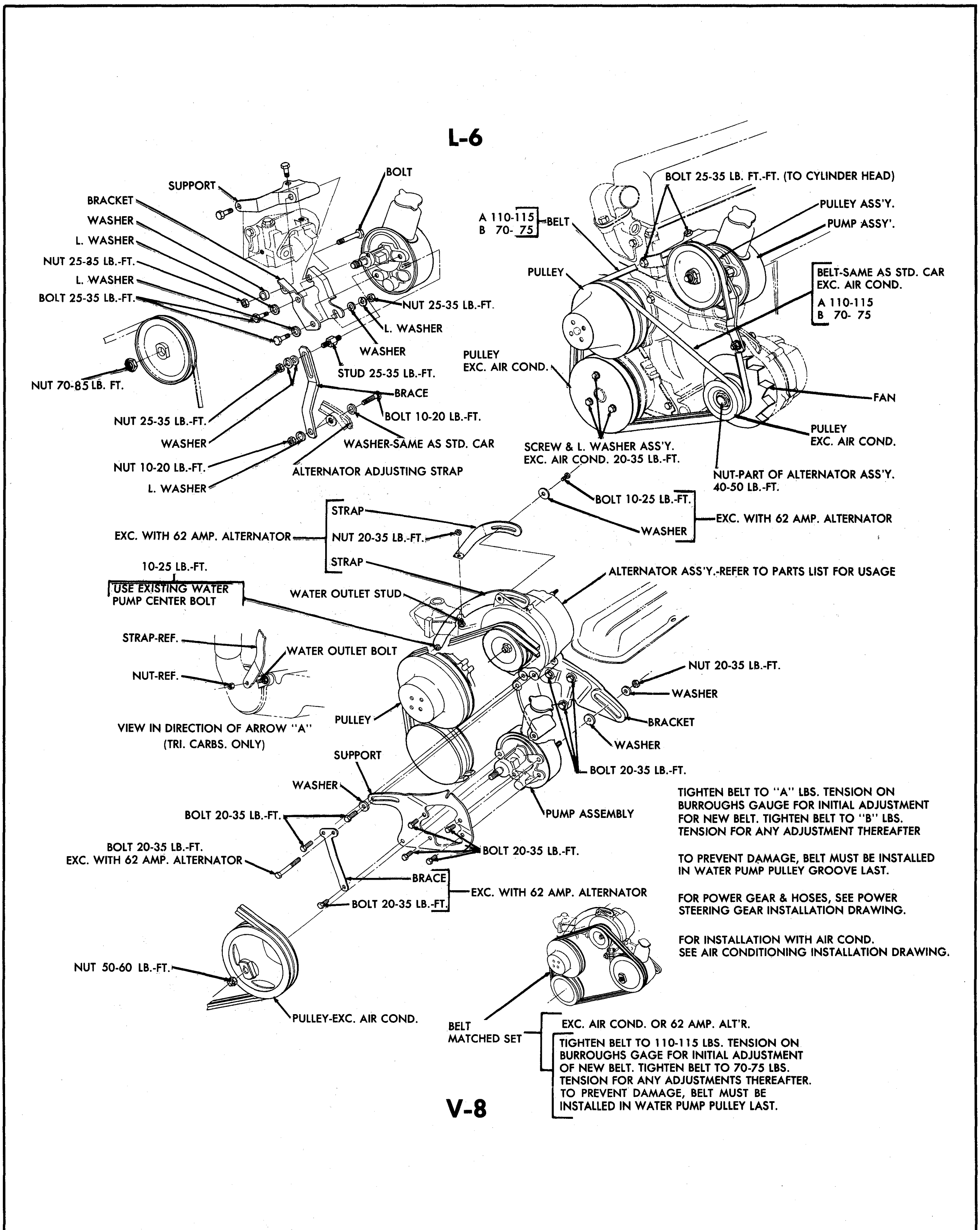



Fig. 9A-39 Power Steering Installation

## ADJUSTMENTS ON CAR

### *PUMP BELT TENSION ADJUSTMENTS*

1. Loosen pump plate (support) to bracket bolts two full turns.

2. Tighten belt with power steering pump to give 70-75 lbs. as indicated on the Burroughs gauge.

3. Holding adjustment, tighten pump plate to bracket bolts.

## PUMP—REMOVE FROM CAR

*(Fig. 9A-39)*

1. Disconnect hoses at pump. When hoses are disconnected, secure ends in a raised position to prevent drainage of oil.

2. Install two caps at pump fittings to prevent drainage of oil from pump.

3. Remove drive pulley attaching nut.

4. Loosen bracket to pump mounting bolts.

5. Remove pump belt.

6. Slide pulley from shaft. Do not hammer pulley off shaft as this will damage the pump.

7. Remove bracket to pump bolts.

8. Drain pump of oil.

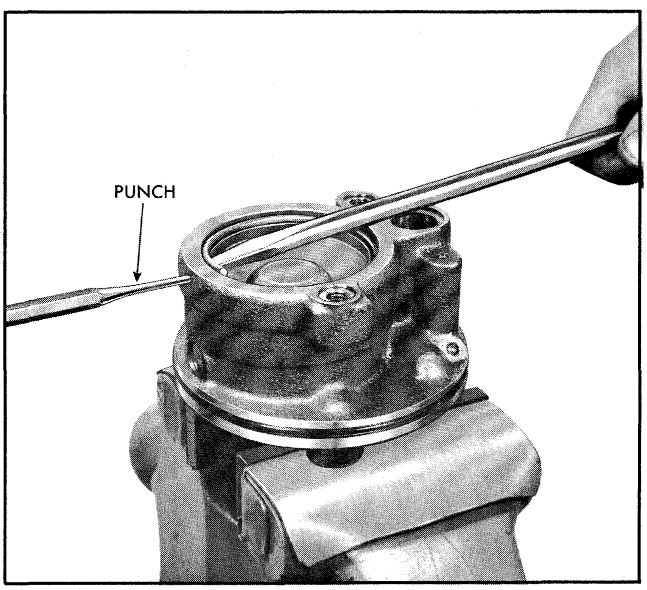



Fig. 9A-40 Removing Retaining Ring

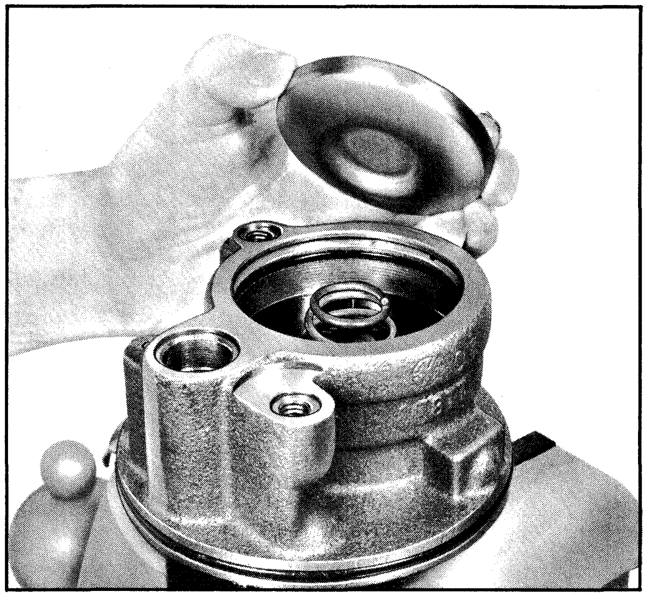


Fig. 9A-41 Removing End Plate

9. Clean exterior of pump.

## DISASSEMBLE

*CAUTION: In clamping pump in vise, be careful not to exert excessive force on front hub of pump as this may distort the bushing.*

1. Remove union and seal.

2. Remove pump rear mounting bolts.

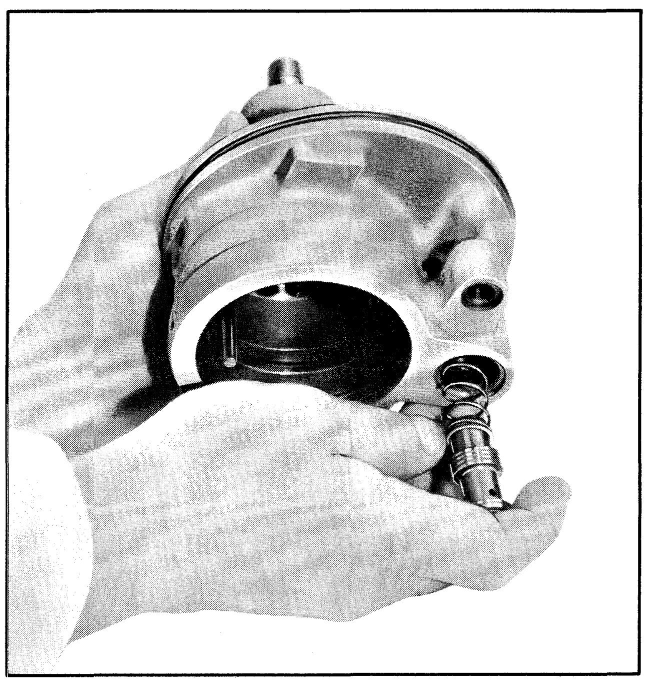


Fig. 9A-42 Removing Flow Control Valve

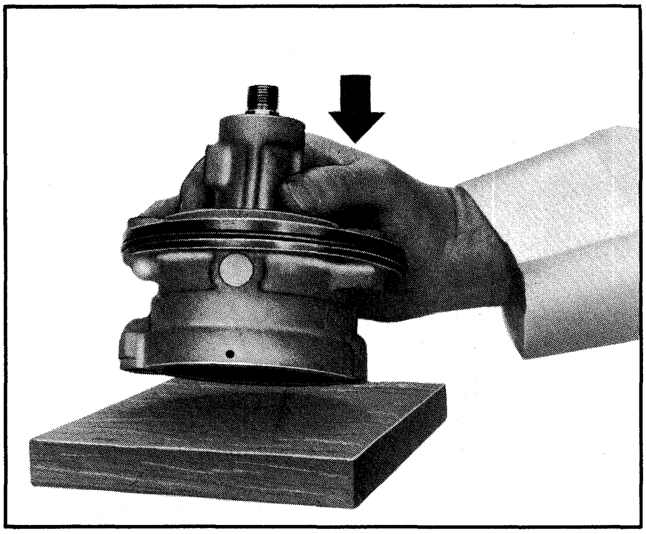


Fig. 9A-43 Removing Pressure Plate

3. Lift reservoir from housing by tapping reservoir at flange, rocking back and forth.

4. Remove mounting bolt and union "O" rings.

5. Remove end plate retaining ring. Push end plate retaining ring out of groove using a punch through 1/8" diameter hole in pump housing (Fig. 9A-40), and remove with screwdriver. End of retaining ring should be next to hole to ease removal.

6. Remove end plate and spring. End plate is spring-loaded and will generally sit above the housing level. If sticking should occur, a slight tapping action will free the plate (Fig. 9A-41).

7. Remove end plate "O" ring.

8. With pump housing turned over remove flow control valve and spring (Fig. 9A-42) and tap housing on wood block until pressure plate falls free (Fig. 9A-43).

9. Remove pressure plate, pump ring and vanes, being careful not to drop parts (Fig. 9A-44).

10. Remount housing in vise. Using a suitable tool, remove shaft retainer on end of drive shaft.

11. Remove rotor and thrust plate.

12. Remove shaft through front of housing (Fig. 9A-45).

## CLEAN PARTS

Carefully clean all parts, except "O" ring seals which are to be replaced and should not be immersed in cleaning solvent. Lubricate all "O" ring seals and the drive shaft seal with vaseline and install in proper location. Be sure not to immerse the drive shaft seal in the cleaning solvent as this could damage it. Fig. 9A-46 shows an exploded view of the pump.

## ASSEMBLE

Be sure all parts are clean during reassembly.

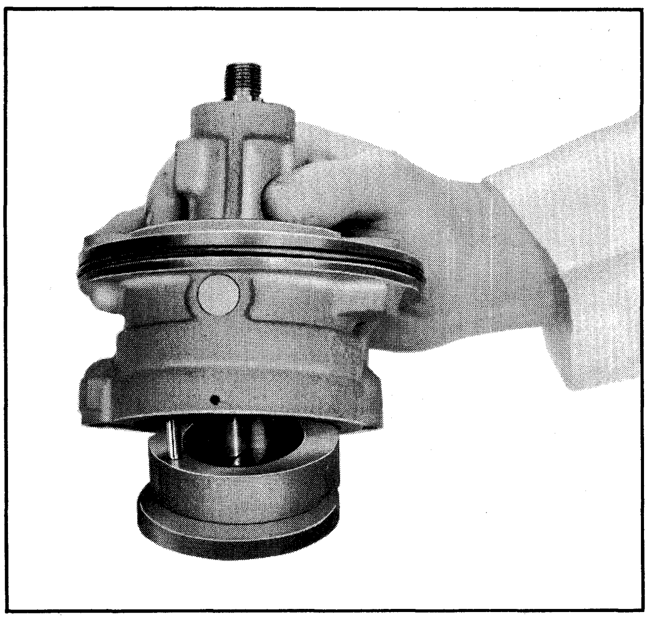


Fig. 9A-44 Pressure Plate and Rotor Ring Removed

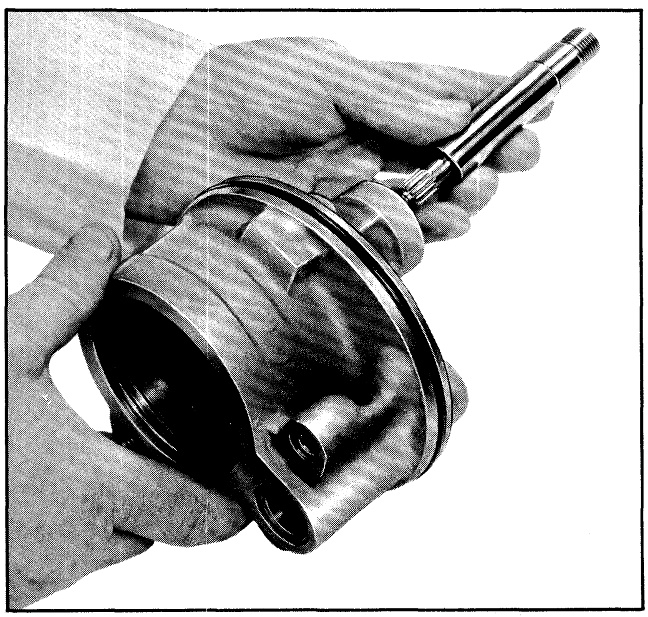
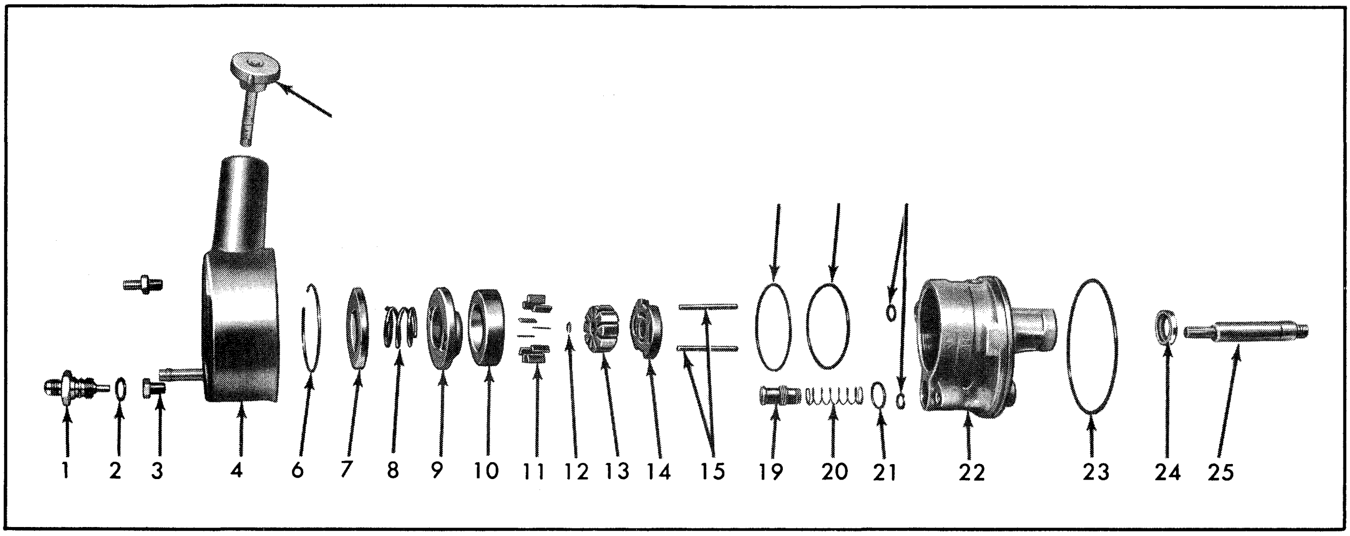


Fig. 9A-45 Removing Pump Shaft




1. Union
2. Seal
3. Mounting Bolts
4. Reservoir
5. Dip Stick and Cover
6. End Plate Retaining Ring
7. End Plate
8. Spring
9. Pressure Plate
10. Pump Ring
11. Vanes
12. C-Washer
13. Rotor
14. Thrust Plate
15. Dowel Pins
16. End Plate "O" Ring
17. Pressure Plate "O" Ring
18. Mounting Bolt "O" Ring Seals
19. Flow Control Valve
20. Flow Control Valve Spring
21. Flow Control Valve "O" Ring Seal
22. Pump Housing
23. Reservoir "O" Ring Seal
24. Shaft Seal
25. Drive Shaft

Fig. 9A-46 Power Steering Pump Exploded View

1. Insert shaft at hub end of housing, spline end entering mounting face side (Fig. 9A-47).

2. Install thrust plate on dowel pins with ported face to rear of pump housing (Fig. 9A-48).

3. Install rotor (must be free on splines) on pump shaft at splined end.

*NOTE: Assemble rotor with flat side toward rear of pump (Fig. 9A-49).*

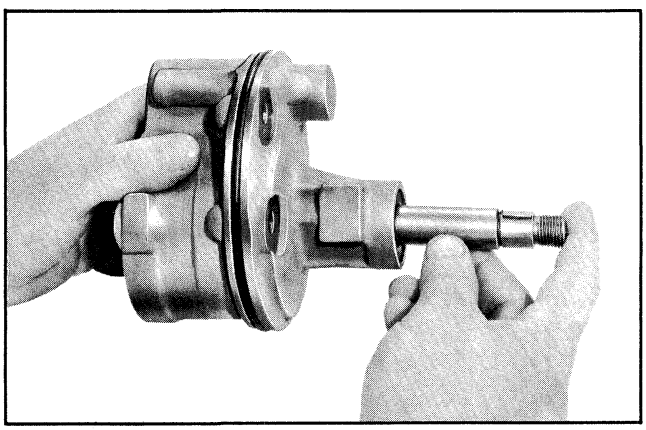


Fig. 9A-47 Installing Pump Shaft

4. Using suitable tool, install shaft retainer.

5. Install pump ring on dowel pins with rotation arrow facing to the rear of pump housing (Fig. 9A-50).

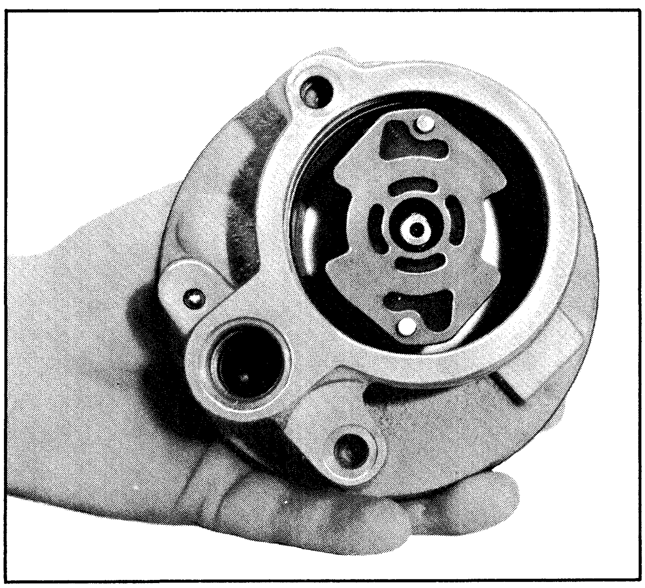


Fig. 9A-48 Thrust Plate Installed

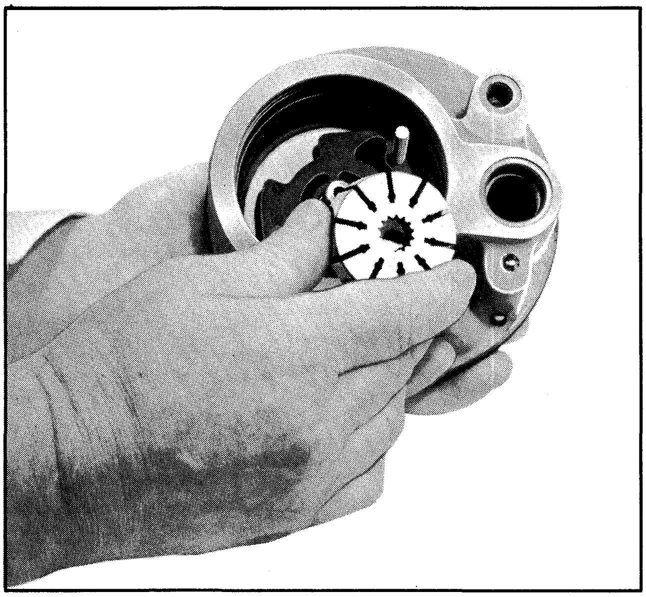


Fig. 9A-49 Installing Rotor

6. Install vanes in rotor slots with radius edge towards outside (Figs. 9A-51 and 9A-52).

7. Lubricate outside diameter and chamfer of pressure plate with vaseline to insure against dam-

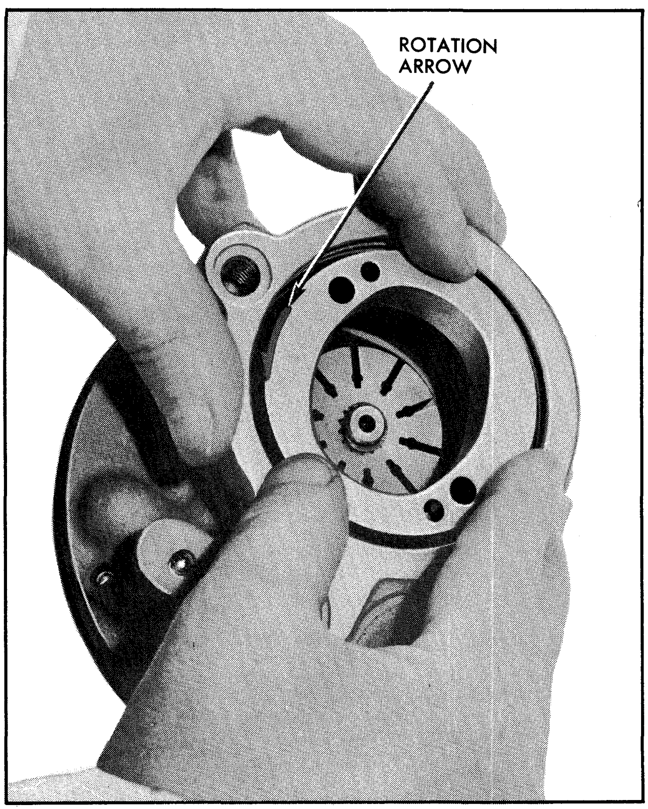



Fig. 9A-50 Installing Pump Ring

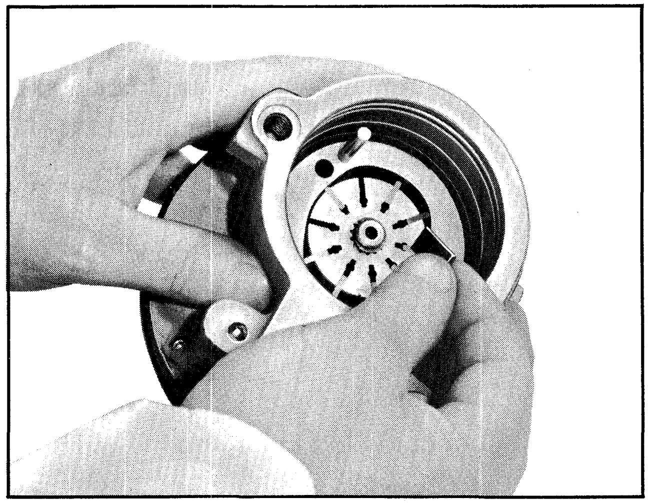


Fig. 9A-51 Installing Pump Vanes

aging "O" ring and install on dowel pins with ported face toward the pump ring. Applying pressure to outer edge only, seat pressure plate. Never press or hammer on the center of the pressure plate as this will cause permanent distortion with resulting pump failure. (Pressure plate will travel about 1/16" to seat).

8. Install end plate "O" ring.

9. Install pressure plate spring in center groove of pressure plate (Fig. 9A-53).

10. Lubricate outside diameter of end plate with vaseline to insure against damaging "O" ring and install in housing using an arbor press.

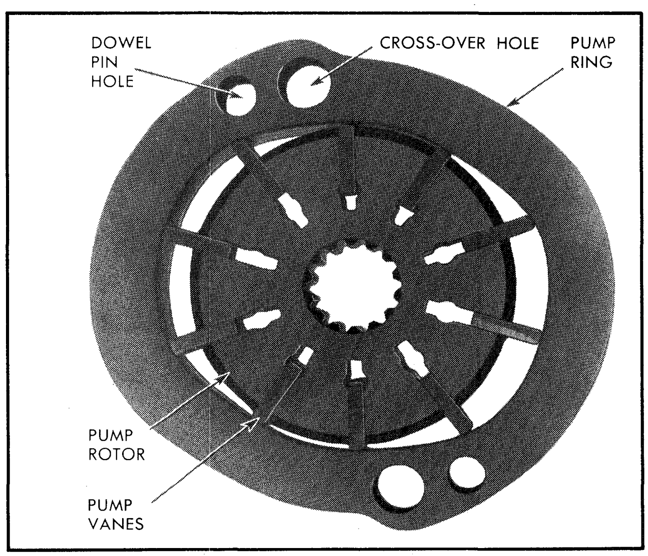



Fig. 9A-52 Pump Vanes Installed

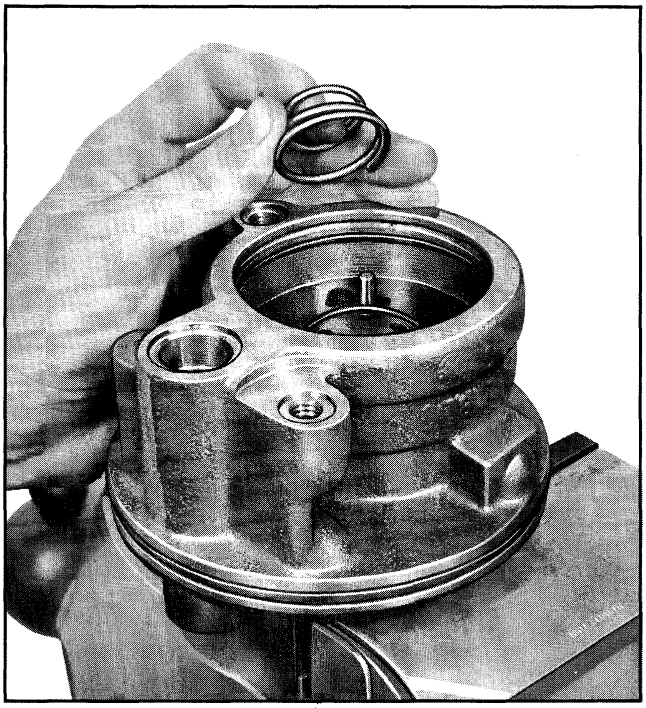


Fig. 9A-53 Installing Pressure Plate Spring

11. Install end plate retaining ring while pump is in arbor press. Be sure it is completely seated in the groove of the housing (Fig. 9A-54).

12. Install flow control spring and flow control plunger. Be sure end with screen goes into bore first.

13. Install mounting bolt and union "O" rings.

14. Drop reservoir into place and press down until reservoir seats on housing.

15. Install studs, torque to 25-35 lb. ft., and outlet union, and torque to 25-35 lb. ft. Install drive shaft key. Support the shaft on the opposite side of key when installing key.

## STEERING PUMP—INSTALL

1. Position pump assembly on mounting bracket with holes lined up and install bolts loosely.

2. Slide pulley on shaft. DO NOT hammer on pulley.

3. Install pulley nut finger tight.

4. Connect and tighten hose fittings. Tighten outlet fitting to 20-30 lb. ft. torque.

5. Fill reservoir. Bleed pump by turning pulley backward (counter-clockwise as viewed from front) until air bubbles cease to appear.

6. Install pump belt over pulley.

7. Move pump until belt has 70-75 lb. as indicated on the Burroughs gauge. Tighten mounting screws.

8. Tighten pulley nut to 70-85 lb. ft. torque.

## TROUBLE DIAGNOSIS

### *1. PUMP NOISE*

The power steering pump is not completely noiseless. Some noise will be present at standstill parking, particularly when the wheels are against the wheel stops. Power steering pump noise can be confused with many other noises, such as, transmission, rear axle, generator, etc. If it is determined that excessive noise is present, remove the pump drive belt, determining if the pump is at fault. If it is determined that excessive pump noise is present, the following steps should be taken.

A. Check belt tightness.

B. Check oil level, filling if necessary.

C. Check to make sure hoses are not touching any other parts of the car, particularly sheet metal.

D. Check the presence of air in the oil. Air will show up as bubbles or the oil will appear milky. Small amounts of air cause extremely noisy operation. If air is present:

1. Tighten all fittings and bolts.

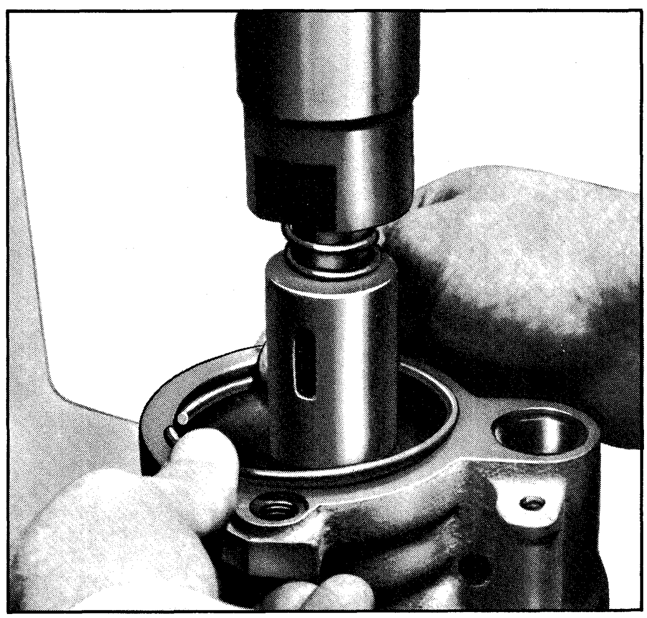


Fig. 9A-54 Installing End Plate

2. Check the entire system for source of air leak. Air can leak into the system where oil passes through at high velocity such as hose connections or at the drive shaft seal.

After each step in attempting to eliminate air, pump should be operated for a few minutes at idle speed while turning steering wheel between extreme positions to allow air to bleed out of oil.

E. If after Step D there is no air present, install pressure gauge in the pressure line between the pump and gear. If, when operating the engine to about 1000 rpm and without turning the steering wheel, the pressure exceeds 125 psi, the hoses and/or steering gear are restricting the oil flow and these parts should be examined to determine the cause of restriction.

F. If the pressure in Step E is less than 125 psi, it will be necessary to remove the pump from the car and disassemble, or partially disassemble, following the steps outlined under "Disassemble Power Steering Pump."

G. Check the pressure plate for scoring.

*NOTE: A high polish is always present on the face as a result of normal wear. Do not confuse this with scoring. Light scoring can be cleaned up by carefully lapping on a flat surface. Be sure to thoroughly wash away all lapping compound.*

H. Check the vanes to insure that radius edge is toward outside and that they operate freely in rotor slots.

I. Check the contour surface of the pump ring for extreme wear. Normally there may be some scuff marks and uniform wear. This is not detrimental to pump function. However, if the wear consists of chatter marks or gouges both the ring and vanes should be replaced.

J. Check the face of the thrust plate for scoring. Light scoring or pick-up can be cleaned by lapping (see G above).

K. Check rotor faces for metal pick-up or scoring. Light scoring or pick up can be cleaned by lapping (see G above).

L. The pump bushing is rarely responsible for noisy operation.

M. Some pump noise is caused by the flow control valve assembly. Install a new plunger and spring if noise is at objectionable level.

N. A swish noise that is present when cornering at slow speed or a growl that cannot be corrected by bleeding system of air, can be eliminated by replacing flow control valve only if smoothing edges of valve with fine hone does not reduce noise.

***PUMP LEAKS:***

A. Tighten all fittings and bolts.

B. Possible sources of pump leakage are as follows:

| LEAK SOURCE | CAUSE | REMEDY |
|---|---|---|
| Top of reservoir | Reservoir too full | Fill to proper level |
| | Excessive air present in oil | Proceed as in 1-D above to determine cause of air |
| At reservoir | "O" ring out or improperly installed. | Replace "O" ring or install properly |
| | Reservoir damaged | Replace reservoir |
| At the pressure fitting or stud | Not tightened sufficiently | Torque to 25-35 lb. ft. |
| | Cross threaded or defective seat on fittings or hose or damaged seals | Correct as necessary |
| At shaft seal | Defective seal or damaged shaft | Replace seal and/or shaft |
| Leaks in metal parts | Defective castings | Replace |

### 3. INOPERATIVE, POOR OR NO ASSIST:

A. Check for loose drive belt.

B. Check and fill reservoir, bleed steering gear.

C. Determine source; pump, steering gear or hoses.

Test No. 1-Oil Circuit Open:

1. Install a pressure gauge in the pressure line between the pump and gear.

2. Turn the steering wheel from one end to the other and note the pressure on the gauge while holding the wheel momentarily against each end. This maximum pressure reading should not be less than 900 psi with the engine idling at 500 rpm, the selector in the "D" range, and the oil temperature in the reservoir between 150° F. to 170° F.

*NOTE: To obtain temperatures of 150°F. to 170°F. desired for testing, turn wheels through normal operating range several times.*

*CAUTION: Do not hold the steering wheel against the stop for any extended period of time.*

If the maximum pressure is below specification, it indicates there is some trouble in the hydraulic circuit. However, it does not indicate whether the pump or the gear is at fault. To determine if the pump, or the gear, or both, are at fault proceed with Test No. 2. It will not be necessary to proceed with Test No. 2 if the pressure as read at each end of wheel travel differs by more than 40 psi. In this case the steering gear is at fault.

Test No. 2-Oil Circuit Closed:

1. Set engine idle to 500 rpm; selector lever in "D" range (in neutral, if synchro-mesh).

2. Turn the shut-off valve of gauge to the closed position.

*NOTE: Shut-off valve must be installed between gauge and steering gear.*

3. Observe and compare the maximum pump pressure at idle. It should not be less than 900 psi.

*NOTE: By comparing this reading with Test No. 1 (testing complete circuit), it is possible to determine whether the fault is with the pump or the steering gear, or both.*

Diagnosis-Test Results

1. If first test is below specifications and second test is equal to or greater than specifications, steering gear is at fault.

2. If first test is below specification and second test is not more than 50 psi greater, pump is at fault.

D. If pump is determined to be at fault, proceed as follows:

1. Remove reservoir and flow control valve. Be sure the flow control valve operates freely in the pump housing bore. If stuck dislodge and check for burrs or dirt that may cause a sticky valve.

2. Check the small screw in the end of the flow control valve for looseness. If loose, tighten, being careful not to damage machined surfaces.

3. Insure that the pressure plate is flat against the pump ring.

4. Check the pressure plate, thrust plate, rotor and ring for scoring as described under "Pump Noise".

5. Check the vanes as described under PUMP NOISE.

6. The internal parts of the flow control valve may be at fault. Try a new assembly. Do not attempt to service parts as this assembly is properly calibrated at the factory.

E. If steering gear is at fault, see section on POWER STEERING GEAR.

### 1. PUMP NOISE:

| CAUSE | REMEDY |
|---|---|
| A. Loose belt | Tighten belt |
| B. Hoses touching other parts of car | Adjust hose positions |
| C. Oil level low | Fill reservoir |

### 1. PUMP NOISE (Continued)

| CAUSE | REMEDY |
|---|---|
| D. Air in the oil | Locate source of air leak and correct |
| E. Excessive back pressure caused by hoses or steering gear. | Locate restriction and correct |
| F. Scored pressure plate (may have been caused by installing the pressure plate by applying force to the center of the plate). | Lap away light scoring. Replace heavily scored or gauled part |
| G. Vanes not installed properly | Install properly |
| H. Vanes sticking in rotor slots | Free up by removing burrs or dirt |
| I. Defective flow control valve | Replace flow control valve assembly |
| J. Extreme wear of pump ring | Replace pump ring |
| K. Face of thrust plate scored | Lap away light scoring. Replace heavily scored part |
| L. Scored rotor | Lap away light scoring. Replace heavily scored part |
| M. Vibration or buzz | Check pump mounting and torque on all attaching nuts and bolts |

### 2. PUMP LEAKS

| LOCATION | CAUSE | REMEDY |
|---|---|---|
| A. Top of reservoir | Reservoir too full | Fill to proper level |
| B. At reservoir | Air in the oil | Locate source of air leak and correct |
| | "O" ring cut | Replace "O" ring |
| | "O" ring improperly installed | Install properly, if damaged, replace |
| C. At pressure fitting or studs | Not tightened sufficiently | Tighten to 25-35 lb. ft. torque |
| | Cross threaded or damaged seat | Replace damaged parts |
| | Defective seat on hose end | Replace hose |
| | Damaged seals | Replace seals |
| D. At the shaft seal | Defective seal and/or shaft | Replace seal and/or shaft |
| E. Leaks in metal parts | Damaged or defective parts | Replace parts as necessary |

### 3. INOPERATIVE, POOR OR NO ASSIST:

| CAUSE | REMEDY |
|---|---|
| A. Loose drive belt | Tighten belt |
| B. Low oil level | Fill reservoir |
| C. Air in the oil | Locate source of air leak and correct |
| D. Defective hoses or steering gear as determined by tests | Correct. See "Power Steering Gear" section |
| E. Flow control valve stuck | Remove burrs or dirt. If bore damaged beyond repair, replace pump housing |
| F. Loose screw in end of flow control valve | Tighten |
| G. Pressure plate not flat against ring | Correct by lapping or replace |
| H. Extreme wear of pump ring | Replace part |
| J. Scored pressure plate, thrust plate and/or rotor | Lap away light scoring. Replace heavily scored parts |
| K. Vanes not installed properly | Install properly |
| L. Vanes sticking in rotor slots | Free up by removing burrs or dirt |
| M. Faulty flow control valve assembly | Replace assembly |

## POWER STEERING PUMP SPECIFICATIONS

Power Steering System Fluid Capacity . . . 2.5 pints

| | |
|---|---|
| **Pump Output** | |
| Minimum . . . . . . . | L-6 1.25 gpm at Idle Speed<br>V-8 1.75 gpm at Idle Speed |
| Maximum (against 50 psi pressure) . . . . | L-6 2.15 gpm at 1500 rpm<br>V-8 2.3 gpm at 1500 rpm |
| **Torque** | |
| Fitting and Plunger Assembly . . . . | 25-35 lb. ft. |
| Hose Connector at Fitting . . . . . . | 20-30 lb. ft. |
| Mounting Stud . . . . . . . . . . . . | 25-35 lb. ft. |
| Pulley Nut . . . . . . . . . . . . . | 70-85 lb. ft. |


## SPECIAL TOOLS

| | |
|---|---|
| J-4245 | Truarc Pliers #3 Internal |
| J-5176-01 | Pressure Checking Gauge (0-2000 lbs.) |
| J-5188 | Valve Cover Seal Installer |
| J-5403 | Truarc Pliers #1 Internal |
| J-5504-A | Pitman Arm Puller |
| J-6217 | Valve Connector Installer |
| J-6219 | Pitman Shaft Seal Installer |
| J-6278 | Pitman Shaft Bushing Remover and Replacer |
| J-5205 | Steering Gear Holding Fixture |
| J-7017 | Oil Pump Seal Installer |
| J-7141 | Gauge Adapter (For J-5176-01) |
| J-7539 | Ball Nut Loading Arbor |
| J-8947 | Piston Installer |
| J-7624 | Adjustable Spanner Wrench |
| J-7663 | Pump Cover Installing Clamp |
| J-7754 | Torque Wrench (0-25 in. lb.) |

Fig. 9A-55 Power Steering Pump and Gear Special Tools

# CHASSIS SHEET METAL

## CONTENTS OF THIS SECTION



## SHEET METAL ALIGNMENT

Proper alignment of the front end sheet metal will provide proper relationship of adjoining sheet metal parts, ease of hood operation and eliminate squeaks, rattles and vibration.

### *FRONT FENDER ALIGNMENT*

Vertical and fore and aft adjustment is provided at rear of fenders by enlarged holes in the fender bracket or body at the attaching points.

Fenders can be moved closer to or farther from the cowl by adding or removing shims between fender and bowl (Fig. 10-5). Fenders can also be adjusted vertically by shifting the fender on the enlarged bolt holes.

1. Check the space between the front door to fender rear edge and adjust as necessary to obtain a parallel space.

2. Check to insure that all connections at the fender attaching bolts are tight.

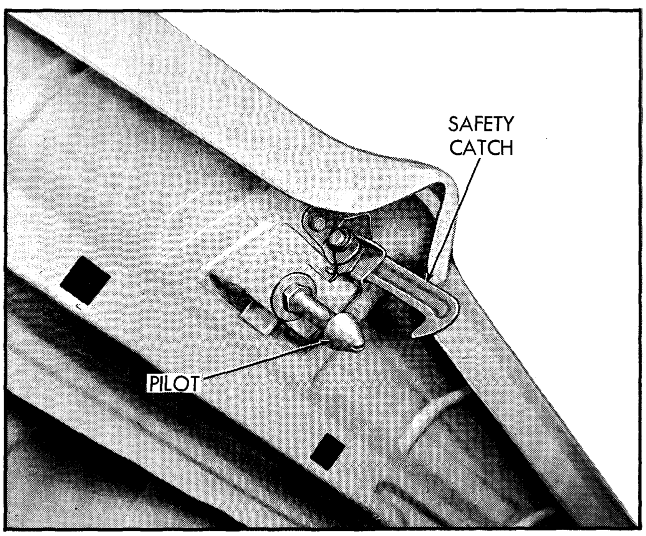



Fig. 10-1 Hood Safety Catch and Pilot

Fig. 10-2 Hood Release Latch

## HOOD

The hood is of rigid sheet metal construction with the outer panel of single sheet metal with a rugged inner panel reinforcement frame. Further rigidity is given by reinforcement diagonal braces strategically located so as to give extra strength at stress points.

1. Slotted holes in the hinge bracket to hood are provided to align hood fore and aft (Fig. 10-5).

2. The parallel space between hood sides and fender is accomplished by the rubber wedges mounted to each fender.

3. The rear corners of the hood should be held down against the hood lacing to keep rear of hood from dancing or vibrating. The rear hood height is adjustable by moving hood hinge at body mount. The hinge bolt holes are enlarged giving room for adjustment.

## HOOD HINGES

The hood is mounted on hinges (Fig. 10-7) mounted to wheel house. Double assist over center springs are used, (one at each hood hinge) both ends of which are fastened to the arms of the hinge. This construction provides hold-open power.

A hood to hinge reinforcement bracket which has two points of attachment is used. Fore and aft adjustment of the hood is provided for by slotted holes in the bracket.

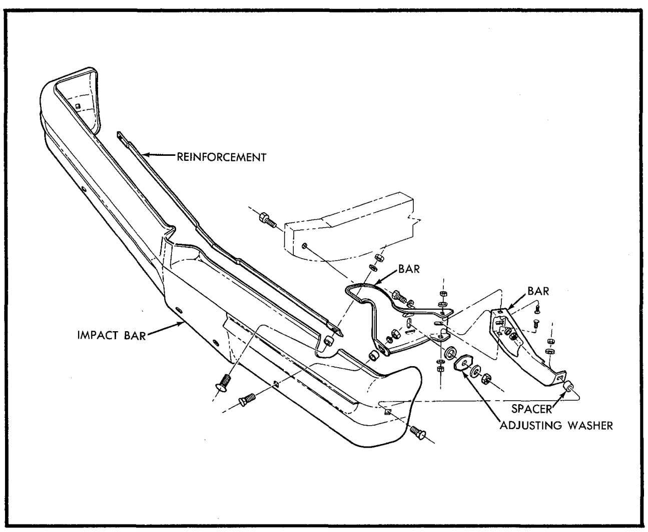



Fig. 10-3 Front Bumper

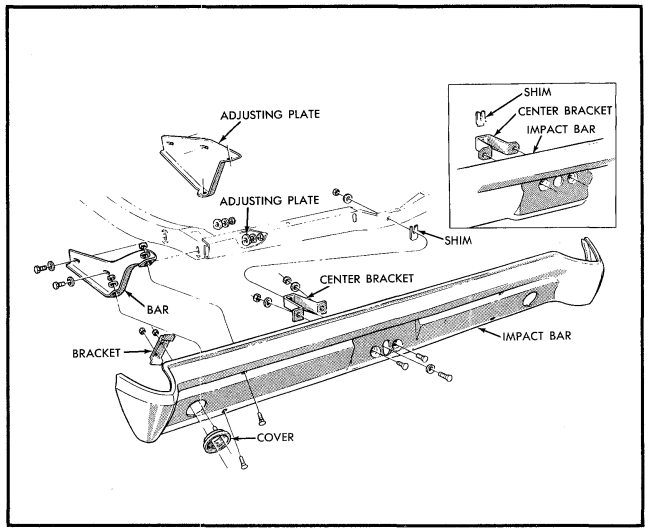



Fig. 10-4 Rear Bumper

## HOOD LATCH

A positive locking hood latch is used and incorporates a safety hood latch and a pilot assembly (Fig. 10-1). The hood latch is fastened to the hood and both assemblies lock to the front fender cross brace when hood is closed. The hood is opened by reaching below the center of the front bumper and pushing release rod toward right front fender (Fig. 10-2). To release the safety latch, reach under partially opened hood and push release lever upward (Fig. 10-2).

## HOOD LATCH ADJUSTMENT

Should the hood be difficult or even fail to release or close, there are 2 adjustments that can be made.

1. To adjust the hood latch fore and aft, shim front screw position.

2. To adjust hood latch, sideways loosen three attaching screws and align latch left or right.

Proper adjustment of hood latch to provide for easy hood closing is as follows:

1. Check tightness of hood latch bolts.

2. Raise or lower hood bumpers on front fender cross brace (Fig. 10-5).

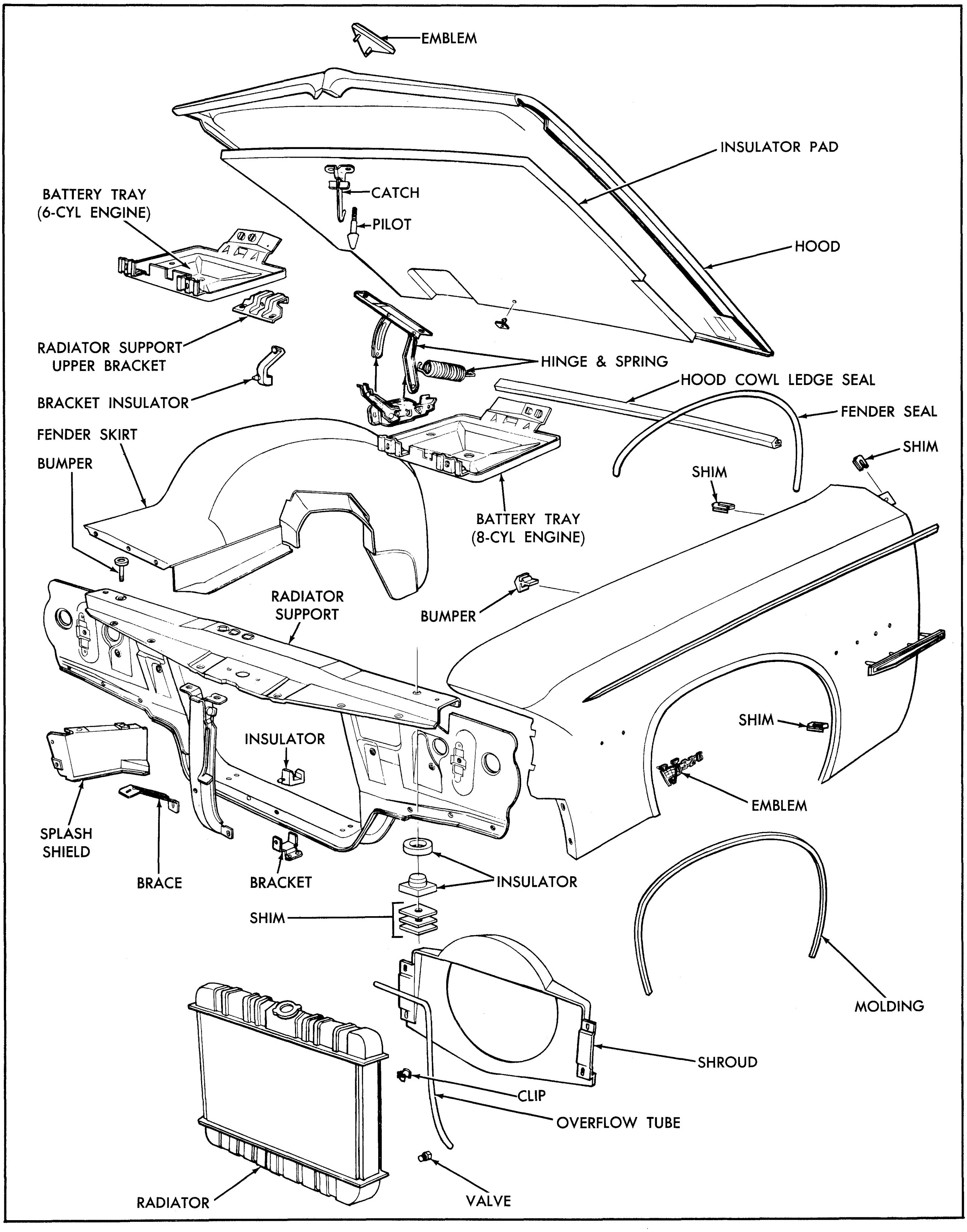



Fig. 10-5 Exploded View—Front End Sheet Metal

3. Press down on nose of hood.

a. If some give or looseness is noticed, hood is not tight and will vibrate and raise up on corners at high speeds. In this case, shorten latch bolt and recheck.

b. If hood is tight with no give, the hood could be properly adjusted or could be too tight.

CHECK AS FOLLOWS:

1. Close hood.

2. Release latch and raise hood 10"-12".

3. Manually close hood with sufficient effort to insure hood tightness.

4. Adjust hood latch assembly and bumpers to permit hood to close flush with fenders and upper grille panel.

### *BUMPER ALIGNMENT*

FRONT AND REAR

The bumper mounting bracket is the only adjusting point for the front or rear bumper. This adjusting point is used for both fore and aft and vertical adjustments.

## SHEET METAL REPLACEMENT

### *FRONT FENDER—REMOVE AND REPLACE*

REMOVE

1. Remove front bumper.

2. Remove fender extension.

3. Remove head lamps and head lamp frame.

4. Remove three screws—fender to lower grille panel.

5. Remove two screws—front fender to front fender cross brace.

6. Remove nine screws—fender to body (upper).

7. Remove one screw—fender to rear upper shroud and one screw—fender to rear lower shroud.

8. Remove fender by lifting up and away.

*NOTE: For right front fender removal, disconnect radiator and antenna mast, remove antenna nut, remove screw from fender rear brace to antenna and let assembly drop through fender.*

REPLACE

To install fender, reverse the above procedure.

### *GRILLE PANEL (UPPER)—REMOVE AND REPLACE*

1. Remove head lamp doors, head lamp and fender extensions.

2. Remove seven upper screws—grille panel to front fender cross brace.

3. Remove ten lower screws—lower to upper grille panel.

4. Lift panel and pull forward.

5. To replace upper grille panel, reverse above procedure.

### *GRILLE PANEL (LOWER)—REMOVE AND REPLACE*

1. Remove bumper.

2. Remove three screws each side—front fender to lower grille panel.

3. Remove one screw each side—fender extension to lower panel.

4. Remove ten screws—lower panel to upper panel.

5. Remove 6 screws, lower panel to lower radiator right and left hand baffle assemblies.

6. Remove lower grille panel forward and down.

7. To replace lower grille panel, reverse the above procedure.

### *GRILLE (RIGHT AND LEFT)— REMOVE AND REPLACE*

1. Remove upper grille panel assembly.

2. Unscrew and remove grille from upper grille panel assembly.

3. To install right or left grille, reverse the above procedure.

### *FRONT FENDER CROSS BRACE REMOVE AND REPLACE*

1. Remove upper grille panel.

2. Remove two supports.

3. Remove battery.

4. Remove three screws each side—baffle assembly to front fender cross brace and two screws each side cross brace to fender.

5. Slide cross brace forward and remove.

6. To install front fender cross brace, reverse the above procedure.

### *HOOD HINGE SPRING—REPLACE*

Hood hinge springs can be removed by propping hood open, and pulling front of spring off of hinge. When replacing the spring, hook the rear end of pin first, then stretch the spring out and hook it at front.

### *HOOD HINGE—REMOVE AND REPLACE*

1. Open hood.

2. While one man holds hood, remove spring, hinge to fender and cowl attaching screws, hinge to hood attaching nuts, and remove hinge.

3. Position new hinge to fender, install and tighten attaching screws.

4. Position hinge to hood and install flat washers, lock nuts and tighten just snug.

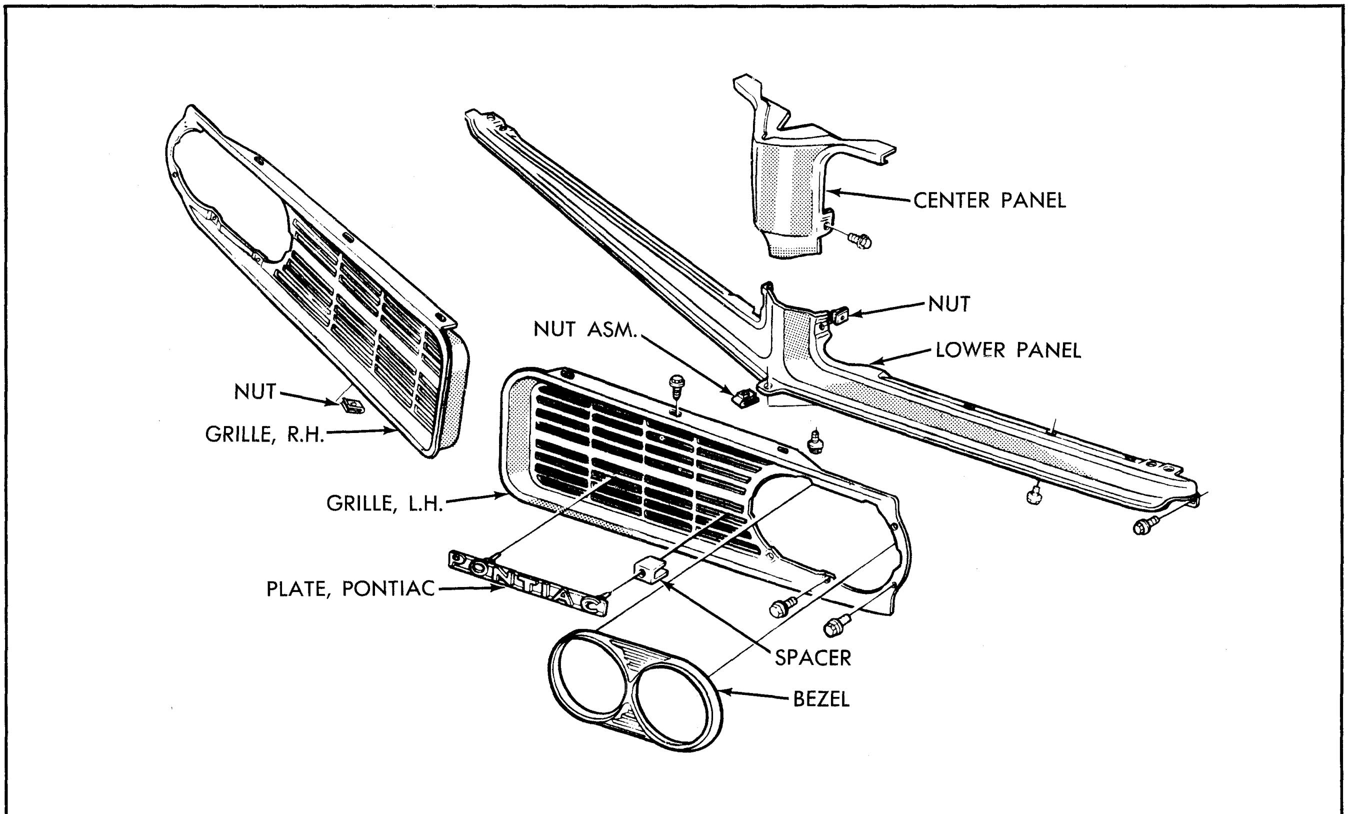



Fig. 10-6 Grille Details

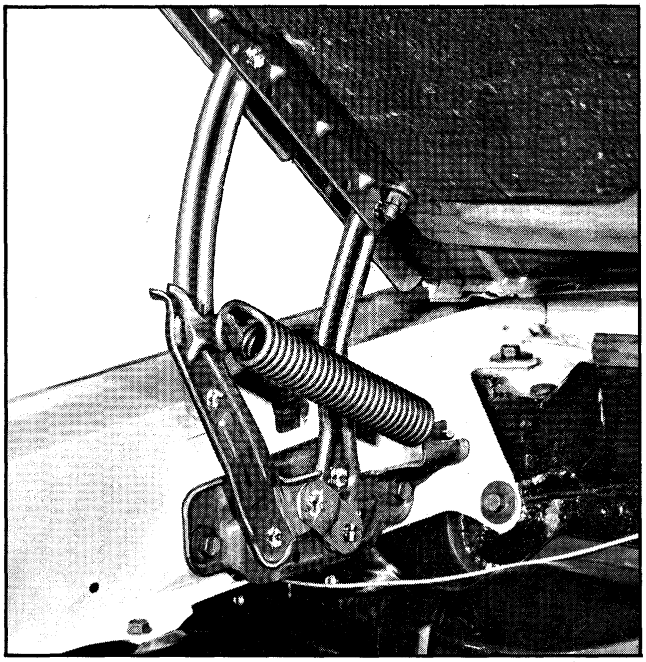


Fig. 10-7 Hood Hinge

5. Replace spring.

6. Close hood and check hood alignment.

7. If hood is misaligned, measure amount of misalignment.

a. Open hood, mark position of hinge relative to hood.

b. Loosen hinge at hood and move hinge the amount it was off.

c. Tighten securely and recheck alignment.

### HOOD—REPLACE

The hood can be removed very quickly by disconnecting it from the hinges at the hood reinforcement.

When replacing the hood, adjust the alignment, one hinge at a time, as outlined in steps 6 and 7 under HOOD HINGE—REMOVE AND REPLACE.

### RADIATOR—REMOVE AND REPLACE

1. Drain radiator.

2. Disconnect overflow, upper and lower radiator hoses.

3. Remove radiator fan shield.

4. Remove radiator.

5. To install radiator, reverse above procedure.

# ELECTRICAL AND INSTRUMENTS

## CONTENTS OF THIS SECTION

The electrical system operates on 12 volts. This section of the manual is subdivided into the following sections:

1. Starting Circuit
2. Charging Circuit
3. Ignition Circuit
4. Lighting Circuit
5. Instruments
6. Windshield Wiper

The complete wiring diagram (less accessories) for all models is shown schematically in Figs. 11-1, 11-2, and 11-3.

# STARTING CIRCUIT

The starting circuit includes the starting motor, solenoid, battery, and cables.

## BATTERY

### DESCRIPTION

The Delco Model 554, 9 plate battery (Fig. 11-4) is a 12 volt, 44 amp hour capacity unit and is used with the 37 amp generator with six cylinder engines. Battery Model 458, 53 amp hour is used with the 37 or 55 amp generators on eight cylinder engines. Battery Model 558, 61 amp hour is used with the 42 amp generator on high performance eight cylinder engines.

*CAUTION: Hydrogen gas is produced by the battery. A flame or spark near the battery may cause the gas to ignite.*

Battery liquid is highly acid. Avoid spilling on clothing or other fabric. This battery has a specific gravity of 1.260-1.280 at full charge at 80°F. The battery date code is located on the second cell cover from the positive post end. This date code should always be included on product information reports or battery correspondence.

### PERIODIC SERVICE

Battery care is extremly important. It should receive the following attention:

1. Check the fluid level in each cell of your battery every two months. If low, add distilled water to bring level to bottom of split ring in cell filler well.

*CAUTION: Do not overfill battery and never add any substance to fluid except distilled water.*

2. Keep battery, battery cable clamps, and battery hold-down bracket clean. Cleaning should be done with a brush and a solution of ammonia and water or baking soda and water. Flush off with clear water. After cleaning, apply petroleum jelly or petrolatum to battery cable clamps and terminals to retard corrosion.

3. If battery performance becomes questionable, check the battery with a "Light Load Test".

*CAUTION: Since batteries give off highly explosive gas, never expose top of battery to an open flame or electric spark. Also, avoid getting battery electrolyte on clothing or other fabrics.*

## REPAIRS

CABLE REPLACEMENT

When replacing battery ground cable be sure the connections are clean and secure. Apply petroleum jelly to cable clamps and terminals to retard corrosion.

SUPPORT REPLACEMENT

When replacing the battery support, it is important that the outer edges of the battery bear firmly and evenly against the support. To provide even support, install shims as necessary between the corners of the support and the support bracket. Battery hold down clamp should be tightened to 2 lb. ft. torque.

### TESTING, BOOSTING AND CHARGING

Inspection

Check outside of battery for damage or signs of serious abuse such as broken case or broken covers.

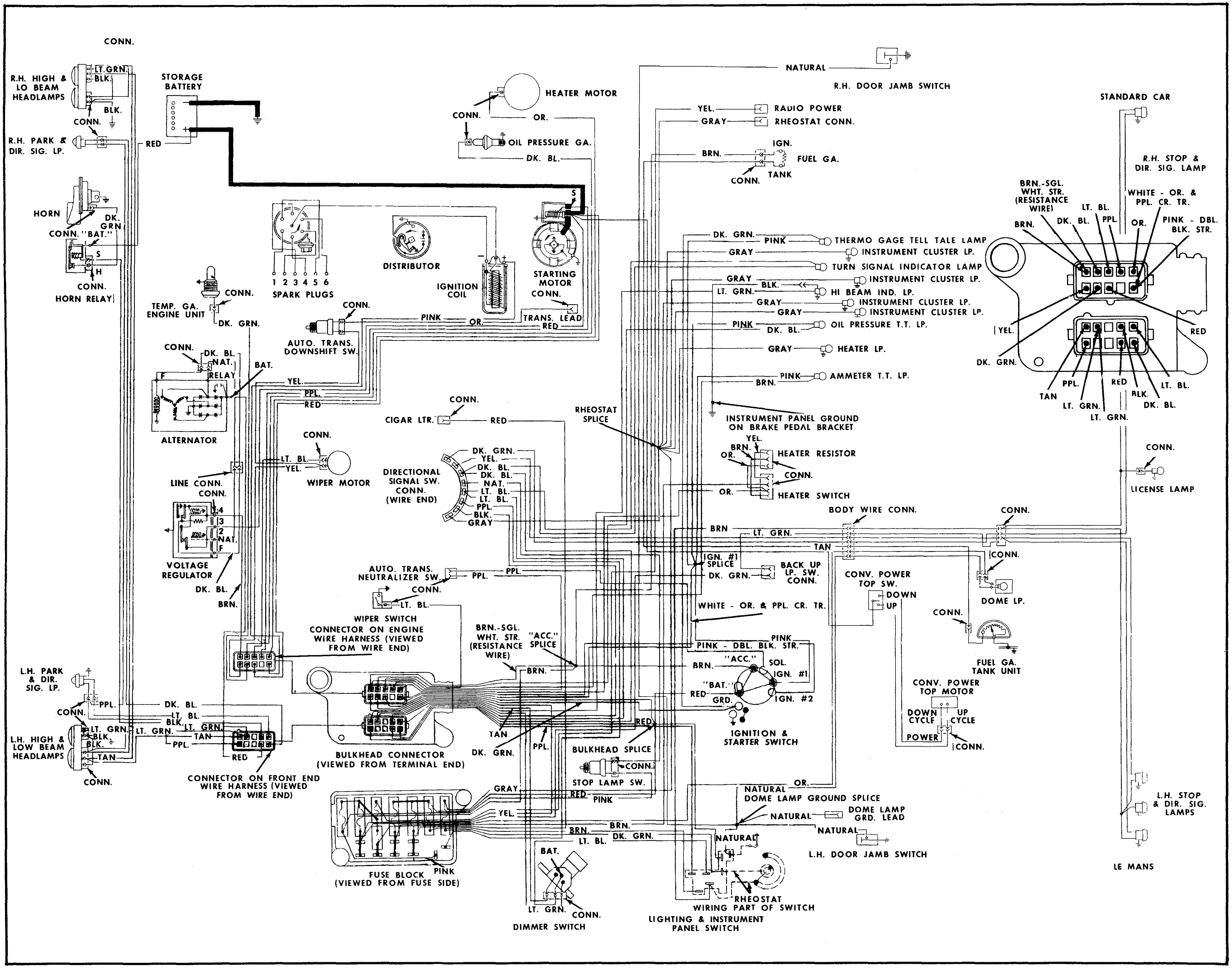



Fig. 11-1 Circuit Diagram - Six Cylinder Engine

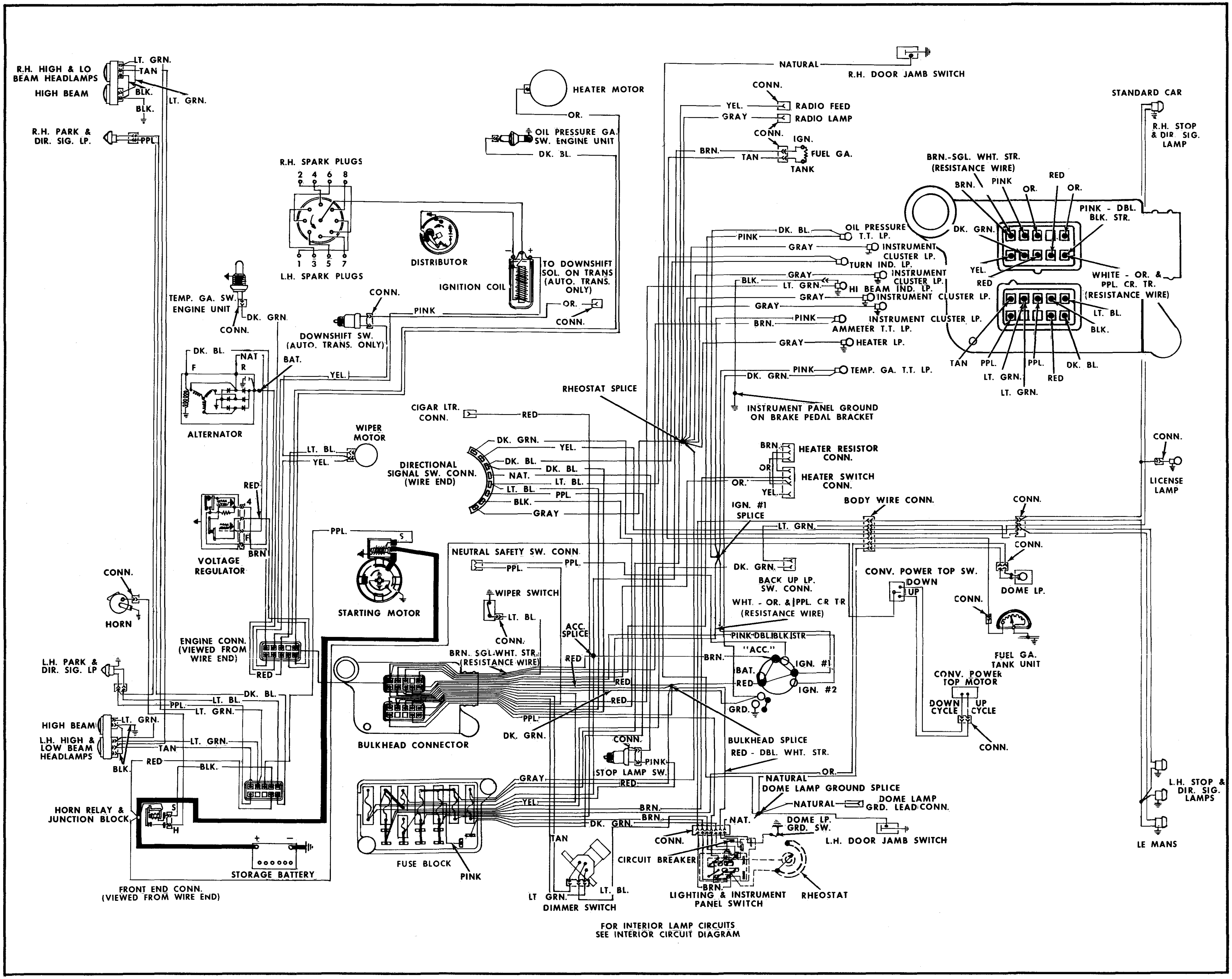



Fig. 11-2 Circuit Diagram - V-8 Engine

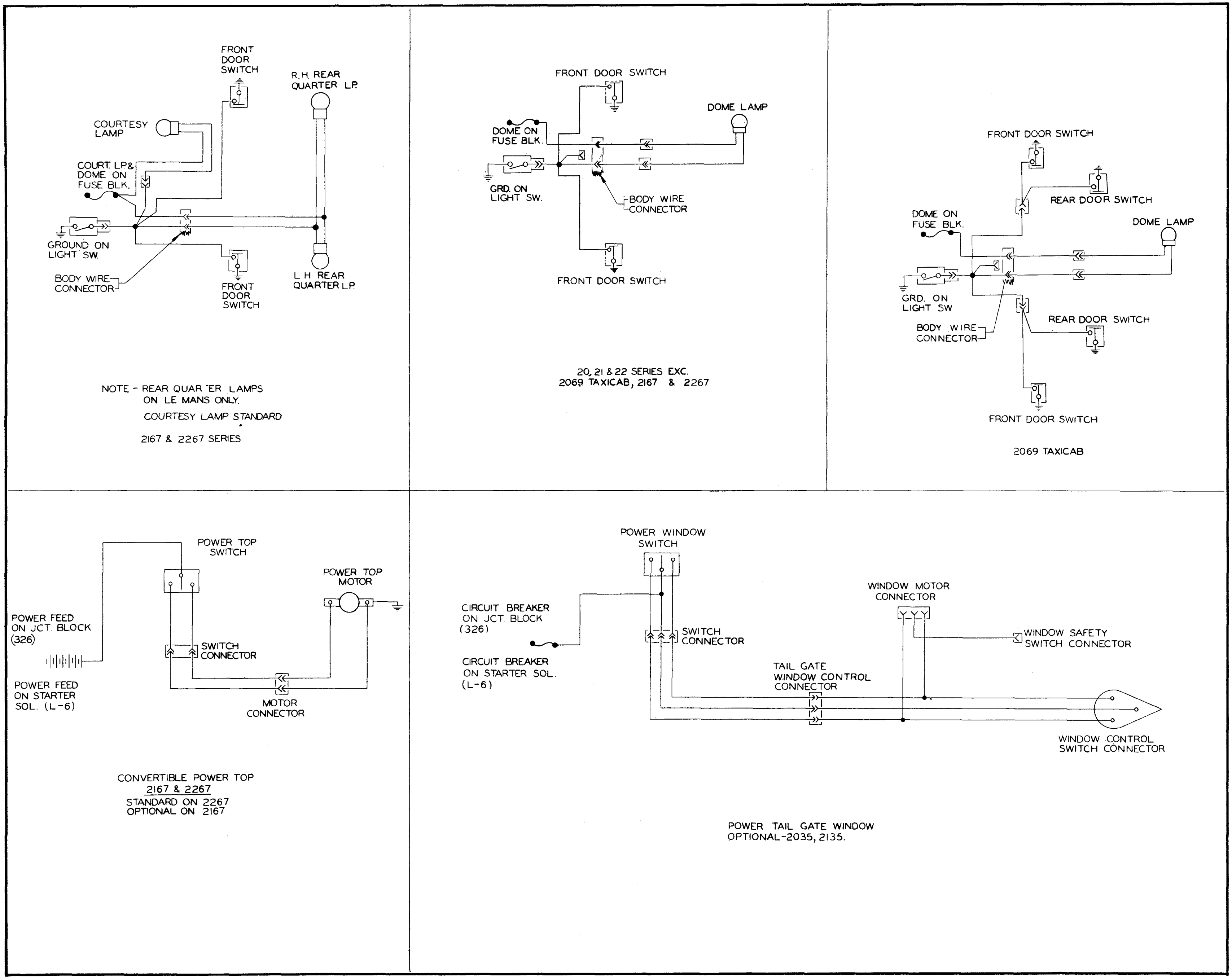



Fig. 11-3 Circuit Diagram - Interior

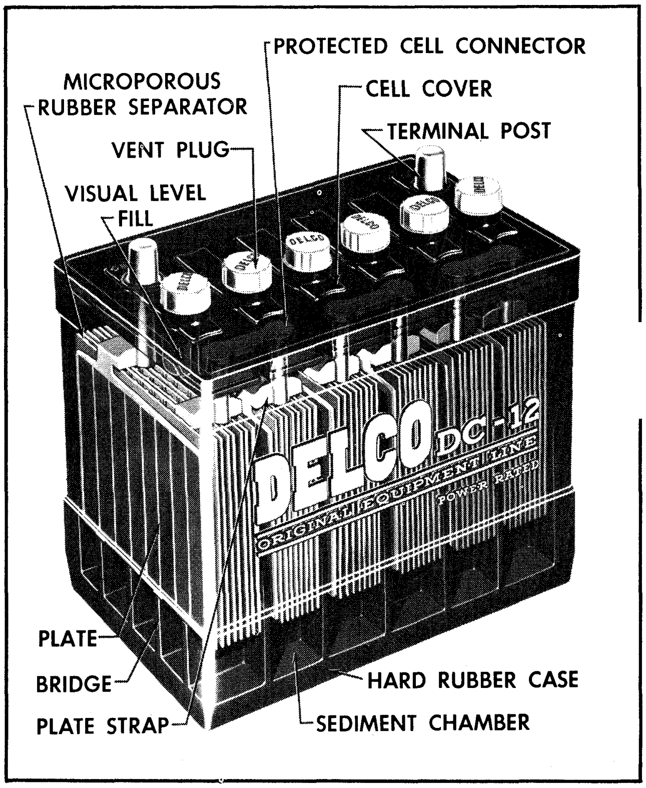



Fig. 11-4 Delco 12 Volt Battery

Check inside of battery by removing the vent caps and inspecting for signs of abuse such as electrolyte level too low, or unusual odors. If battery shows signs of serious damage or abuse, it should be replaced. If not, make Light Load Test.

Light Load Test

Check electrical condition of battery cells as follows:

1. Place load on battery by holding starter switch "ON" for 3 seconds or until engine starts. If engine starts, turn off ignition IMMEDIATELY.

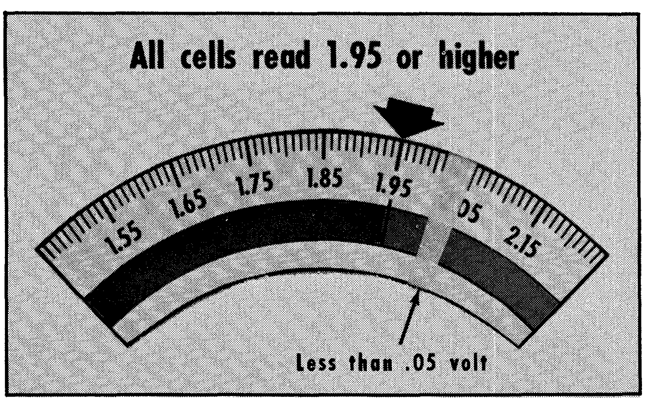



Fig. 11-5 Good Battery - Sufficiently Charged

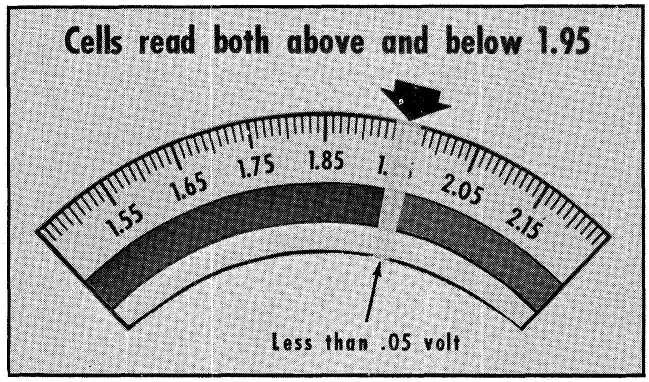



Fig. 11-6 Good Battery - Requires Charging

2. Turn on headlights (low beam). AFTER 1 minute, with lights still "ON", read voltage of each battery cell with voltmeter, noting the exact voltages. It is necessary to remember only the highest and lowest cell voltage.

a. Good Battery — Sufficiently Charged (Fig. 11-5)

If all cells read 1.95 volts or more and the difference between the highest and lowest cell is less than .05 volt, battery is good and sufficiently charged.

b. Good Battery — Requires Charging (Fig. 11-6)

If cells read both above and below 1.95 volts and the difference between the highest and lowest cell is less than .05 volt, battery is good but requires charging. Charge according to Delco Battery Charging Guide.

c. Poor Battery — Replace (Fig. 11-7)

If any cell reads 1.95 volts or more and there is a difference of .05 volt or more between the highest

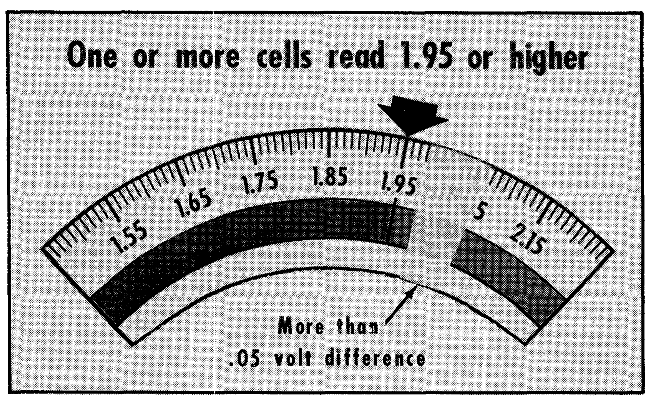



Fig. 11-7 Poor Battery - Replace

and lowest cell, the battery is defective, damaged, or worn out and should be replaced.

d. Discharged Battery — Boost-Charge and Retest (Fig. 11-8).

If all cells read less than 1.95 volts, battery is too low to test accurately. Boost-Charge and repeat Light-Load Test.

CHARGING GUIDE FOR TYPICAL PASSENGER CAR BATTERIES

Suggested Battery Charging Rates:

1. For those dry charged batteries being activated with electrolyte at a temperature under 60°F or those batteries which are expected to go into immediate operation in below freezing weather--

| Type Battery | Amp-Hour Capacity | | Dry Battery Warm-Up Charge |
|---|---|---|---|
| 12 Volt | 100 or less | TIME | 10 Min. |
| | | RATE | 15 Amps |

2. For those batteries which require a boost charge for the "Light Load Test" procedure--

| Type Battery | Amp-Hour Capacity | | Light Load Test Boost Charge |
|---|---|---|---|
| 12 Volt | 100 or less | TIME | 20 Min. |
| | | RATE | 50 Amps |

3. For those batteries which have become discharged and require charging. It should be recognized that slow charging is the best and only method of completely recharging batteries. However, since

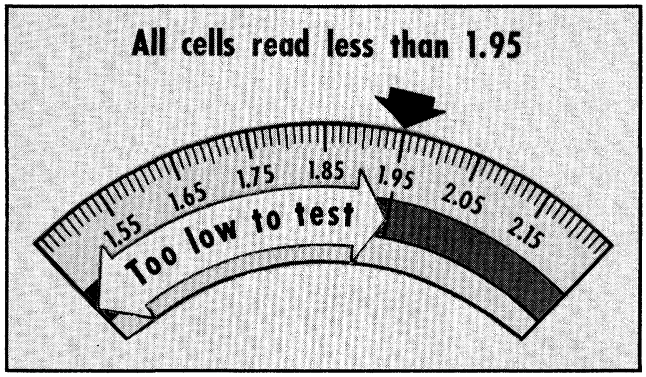



Fig. 11-8 Boost - Charge and Retest

time is often of importance to the battery owner two other methods are offered for partial battery re-charges--

| Type Battery | Amp-Hour Capacity | | Slow Charging |
|---|---|---|---|
| 12 Volt | 100 or less | TIME | 24 Hours |
| | | RATE | 4 Amps |

| | Fast Charging |
|---|---|
| TIME | 1 Hour* |
| RATE | 40 To 50 Amps* |

*Provided electrolyte temperature does not rise above 125°F.

## TROUBLE DIAGNOSIS

If the battery remains undercharged, check for loose generator belt, defective generator, high resistance in the charging circuit, oxidized regulator contact points, or a low voltage setting.

If the battery uses an abnormal amount of water, the voltage regulator setting may be too high.

Measure the terminal voltage of the battery during cranking. Disconnect distributor to coil primary wire during this check to prevent engine firing. If the terminal voltage is less than 9.0 volts, remove the battery from service for further checking.

## STARTING MOTOR

### DESCRIPTION

The enclosed shift lever starting motor (Fig. 11-9) is a 12-volt extruded frame type unit.

The starting motor has the solenoid shift lever mechanism and the solenoid plunger enclosed in the drive housing, thus protecting it from exposure to road dirt, icing conditions and splash. It has an overrunning clutch type of drive. The overrunning clutch is operated by a solenoid switch mounted to a flange on the starting motor drive housing. Instead of a nameplate, lettering and model numbers are rolled into the outside of the field frame, thereby providing a more permanent type of identification.

The 6-cylinder engine starting motor has four poles and four field coils. The field circuit used in this motor is a series field. The V-8 engine starting motor has three series windings and one shunt winding.

The motor has a series field in which all four field coils are connected in series from the motor terminal of the solenoid to the insulated brushes. The end of the field windings extends out through a rubber grommet assembled in an opening in the frame and is attached directly to the "motor" terminal of the solenoid. The rubber grommet insulates the extended end of the field windings from the frame (ground) and prevents dirt, water and oil from entering the motor.

The brush rigging has brush arm supports attached directly to the extruded section of the field frame. One ground brush and one insulated brush are both pivoted from the same brush holder support, thus only two brush holder supports are required. A single ribbon type spring applies tension to each pair of brushes.

An overrunning clutch type of drive is used to engage the cranking motor pinion with the flywheel. The flange mounted solenoid switch operates the overrunning clutch drive by means of a linkage to the shift lever. When the control switch is closed

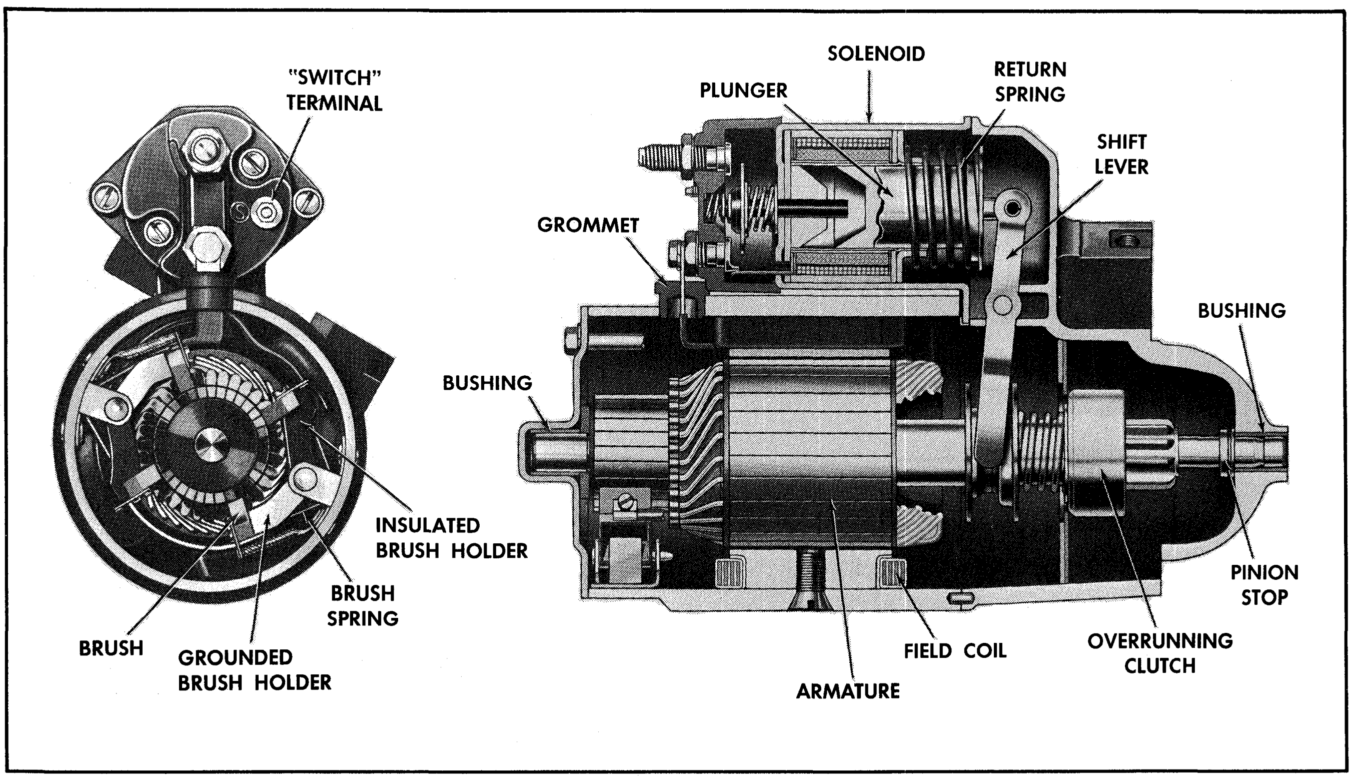



Fig. 11-9 Cross Section of Starting Motor

the solenoid is energized, shifting the cranking motor pinion into mesh with the flywheel. Battery current is delivered to the motor when the main contacts of the solenoid are then closed. The armature rotates and turns the flywheel. Overrunning action of the clutch protects the cranking motor armature from excessive speed when the engine fires. A compression type spring located inside the solenoid case returns the shift lever and clutch to their normal at-rest position.

The armature shaft and clutch have mating spiral splines which aid in meshing of the gears and thus prevents transmission of cranking power until the clutch pinion is fully engaged in the flywheel ring gear. A special assist spring is located around the armature shaft between the end fiber of the armature and the collar of the clutch drive. This spring aids the solenoid in overcoming the return spring force in the first movement of the clutch along the armature shaft. A pinion stop, consisting of a snap ring and retainer and a thrust collar assembled on the armature shaft, takes all the end thrust.

The solenoid is attached to the drive end housing with two screws. A molded push rod is assembled in the contact assembly. A shoulder molded on the push rod and a cup that can be easily assembled to the rod and locked into position over two molded bosses, holds the contact assembly in place.

## PERIODIC SERVICE

No periodic lubrication of the starting motor or solenoid is required. The motor and brushes cannot be inspected without disassembling the unit, so no service is required on the motor or solenoid between overhaul periods.

## CHECKS AND ADJUSTMENTS ON CAR

Although the starting motor cannot be checked against specifications on the car, a check can be made for excessive resistance in the cranking circuit. To check for excessive resistance in the cranking circuit, measure:

1. The voltage drop, during cranking, between the insulated battery post and the battery terminal of the solenoid.

2. The voltage drop, during cranking, between the battery terminal of the solenoid and the motor terminal of the solenoid.

3. The voltage drop, during cranking, between the grounded battery post and the starting motor frame.

*CAUTION: To prevent the engine from firing during the above checks, disconnect the primary lead to the distributor, either at the distributor or at the coil.*

If the voltage drop for any one of the above three checks exceeds 0.2 volt, excessive resistance is indicated in that portion of the cranking circuit being checked. Locate and eliminate the cause for any excessive voltage drop in these circuits in order to obtain maximum efficiency of the cranking system.

When the solenoid fails to pull in, the trouble may be due to excessive voltage drop in the solenoid control circuit. To check for this condition, close the starting switch and measure the voltage drop between the battery terminal of the solenoid and the switch terminal of the solenoid. Excessive resistance in the solenoid control circuit is indicated and should be corrected if this voltage drop exceeds 3.5 volts.

If the voltage drop does not exceed 3.5 volts and the solenoid does not pull in, measure the voltage available at the switch terminal of the solenoid. If the solenoid does not feel warm, it should pull in whenever the voltage available at the switch terminal is 7.7 volts or more (when the solenoid feels warm, it will require a somewhat higher voltage to pull in).

## REMOVE FROM CAR

1. Disconnect battery ground cable at battery terminal post.

2. Disconnect battery positive cable and wiring harness leads from starting motor solenoid.

3. Remove starting motor.

## DISASSEMBLE STARTER

1. Disconnect the field strap (Fig. 11-9) from terminal on solenoid.

2. Remove through bolts.

3. Remove commutator end frame, leather washer, field frame assembly, and armature assembly from drive housing.

4. Remove overrunning clutch from armature shaft as follows:

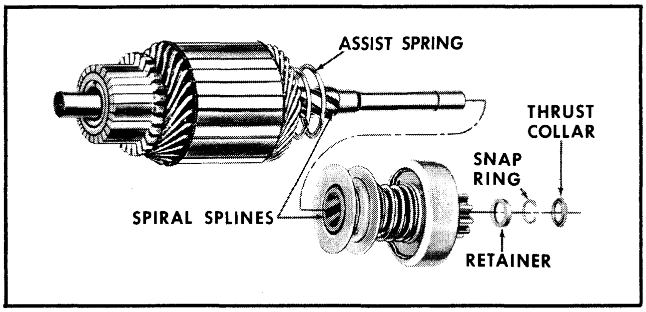



Fig. 11-10 Armature and Overrunning Clutch Assembly

a. Slide thrust collar (Fig. 11-10) off end of armature shaft.

b. Slide a standard half inch pipe coupling or other metal cylinder of suitable size (an old pinion of suitable size can be used if available) onto shaft so end of coupling or cylinder butts against edge of retainer (Fig. 11-11). Tap end of coupling with hammer, driving retainer towards armature and off snap ring.

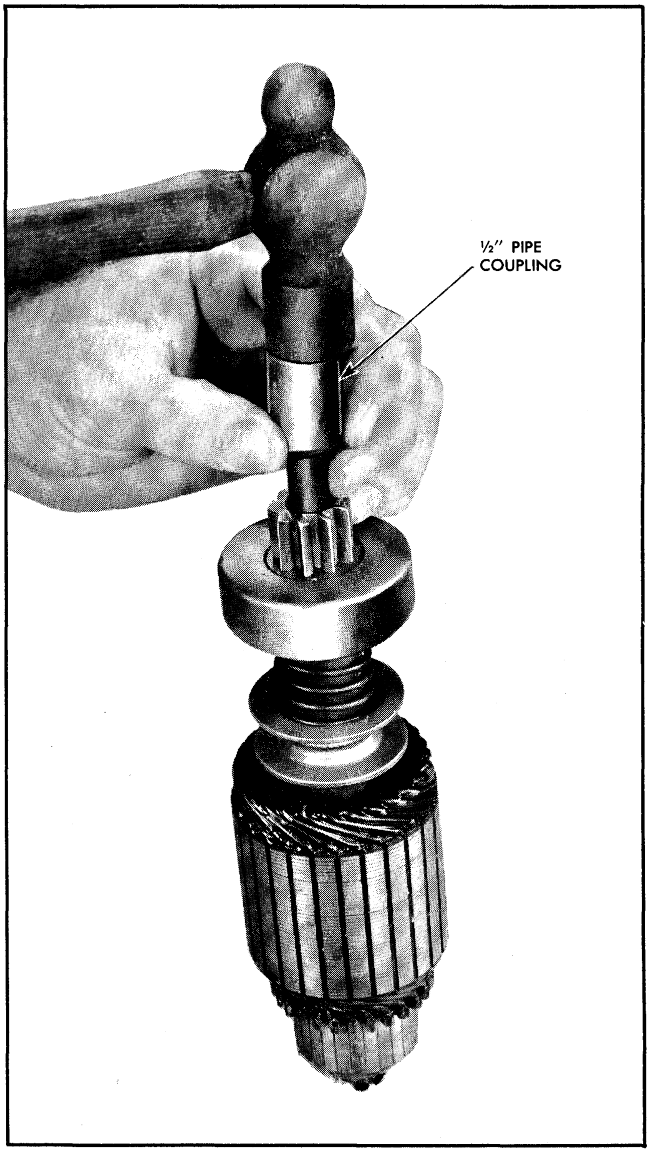



Fig. 11-11 Driving Retainer Off Snap Ring

c. Remove snap ring from groove in shaft using pliers or other suitable tool. If snap ring is too badly distorted during removal it may be necessary to use a new one when reassembling clutch.

d. Slide retainer and clutch from armature shaft.

REMOVE SOLENOID

1. Remove solenoid to drive housing attaching screws and remove solenoid.

2. Remove solenoid return spring.

3. Remove shift lever pivot pin.

4. Remove shift lever and plunger assembly.

## *DISASSEMBLE SOLENOID*

1. Remove nuts from the motor terminal and switch terminal and the two attaching screws.

2. Using care, remove cover.

*CAUTION: These terminal studs have welded lead connections. Do not twist during removal of nuts.*

## *CLEAN AND INSPECT*

1. If the solenoid contacts are slightly burned or dirty, the contacts should be cleaned. When the contacts are badly burned, the burned parts should be replaced.

2. Test overrunning clutch action. The pinion should turn freely in the overrunning direction. Check pinion teeth to see that they have not been chipped, cracked, or excessively worn. Replace assembly if necessary. Badly chipped pinion teeth may indicate chipped teeth on the ring gear. This should be checked under such conditions and replaced if necessary.

3. Check brush holders to see that they are not deformed or bent, but will properly hold brushes against the commutator.

4. Check fit of armature shaft in bushing of drive housing. Shaft should fit snugly in the bushing. If the bushing is worn, it should be replaced.

5. The overrunning clutch, armature and fields should not be cleaned in any degreasing tank, or with grease dissolving solvents, since these would dissolve the lubricant in the clutch mechanism and would damage the insulation in the armature and field coils. It is suggested that all parts except the clutch, be cleaned with oleum spirits and a brush. The clutch can be wiped with a clean cloth.

If the commutator is dirty it may be cleaned with No. 00 sandpaper. Never use emery cloth to clean commutator.

## SERVICE

### ARMATURE

If the armature commutator is worn, dirty, out of round or has high insulation, the armature should be put in a lathe so the commutator can be turned down. The insulation should then be undercut 1/32 of an inch wide and 1/32 of an inch deep, and the slots cleaned out to remove any trace of dirt or copper dust. As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper to remove any burrs left as a result of the undercutting procedure.

The armature should be checked for opens, short circuits and grounds as follows:

1. Open—The most likely place for an open to occur is at the commutator riser bars as a result of excessively long cranking periods. Inspect the points where the conductors are joined to the commutator bars for loose connections. The poor connections cause arcing and burning of the commutator bars as the starting motor is used. If the bars are not too badly burned, repair can be effected by resoldering the leads in the riser bars (using rosin flux), and turning down the commutator in a lathe to remove the burned material. The insulation should then be undercut.

2. Short Circuit—Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler with a steel strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuit is located. Shorts between bars are sometimes produced by brush dust or copper between the bars. These shorts can be eliminated by cleaning out the slots.

3. Ground—Grounds in the armature can be detected by the use of 110-volt test lamp and test points. If the lamp lights when one test point is placed on the commutator with the other point on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure which is often brought about by overheating of the starting motor produced by excessively long cranking periods or by accumulation of brush dust between the commutator bars and the steel commutator ring.

### FRAME AND FIELD

The field winding can be checked for an open or a ground by using a test lamp as follows:

1. Ground—Touch one lead of the 110-volt test lamp to the grounded brush and the other lead to the field connector strap (Fig. 11-12). If the lamp lights,

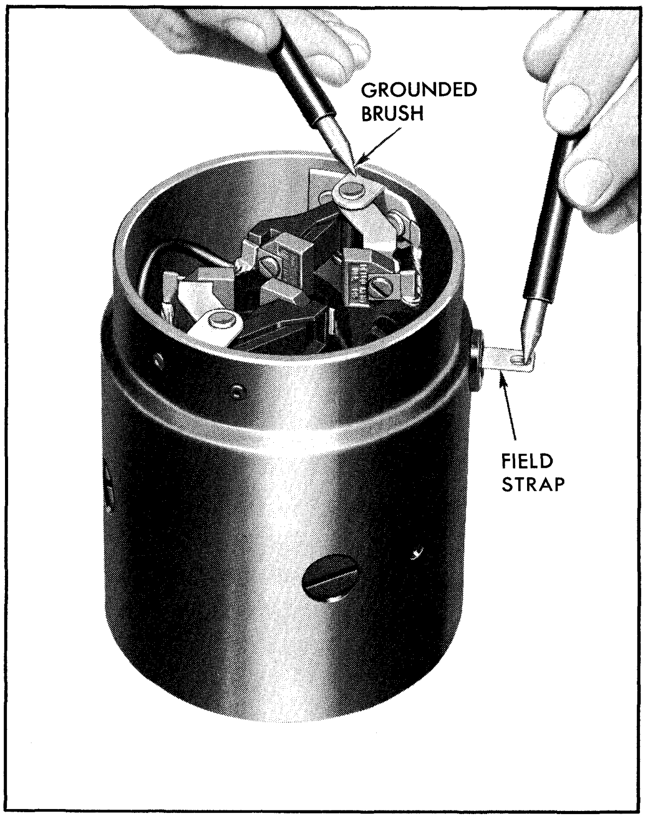



Fig. 11-12 Testing Field Coils for Ground

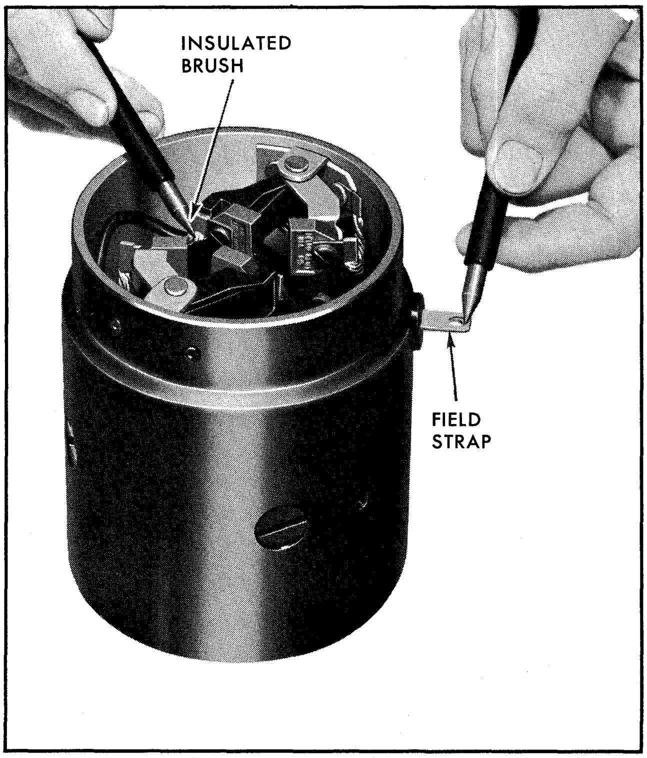



Fig. 11-13 Testing Field Coils ofr Open Circuit

at least one field coil is grounded and the defective coil will require repair or replacement.

2. Open—Touch one test lamp lead to insulated brush and one lead to field connector strap (Fig. 11-13). If lamp does not light, the series field coils are open.

3. On V-8 engine starting motors, place one lead on each end of the shunt coil. Disconnect the shunt coil grounds before this check is made. If the lamp does light, the shunt coil is open and will require replacement.

FIELD COIL REMOVE

Field coils can be removed from the field frame assembly most easily by use of a pole shoe screwdriver. A pole shoe spreader should also be used since this prevents distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place. Formed insulators are used to protect the field leads from grounding to the frame. These must be replaced on assembly.

***REPLACE BRUSHES***

1. Remove brush holder pivot pin which positions one insulated and one grounded brush.

2. Remove brush spring.

3. Replace brushes as necessary.

To assembly, reverse above procedure.

***ASSEMBLE SOLENOID***

1. When reassembling the cover on the solenoid make sure the terminal studs are properly positioned in cover. The cover gasket must be centered under the cover to insure proper sealing.

2. Install cover attaching screws and install nuts on motor and switch terminals.

INSTALL SOLENOID

1. Install plunger and lever assembly and pivot pin.

2. Install return spring.

3. Attach solenoid to starter drive housing and secure with two attaching screws.

***ASSEMBLE STARTER***

1. Assemble overrunning clutch to armature shaft as follows:

a. Lubricate drive end of armature shaft with high melting point grease.

b. Slide clutch assembly onto armature shaft with pinion outward (Fig. 11-11).

c. Slide retainer onto shaft with cupped surface facing end of the shaft (Fig. 11-11).

d. Stand armature on end of wood surface with commutator down. Position snap ring on upper end of shaft and hold in place with a block of wood. Hit wood block a blow with hammer forcing snap ring over end of shaft. Slide snap ring down into groove (Fig. 11-14).

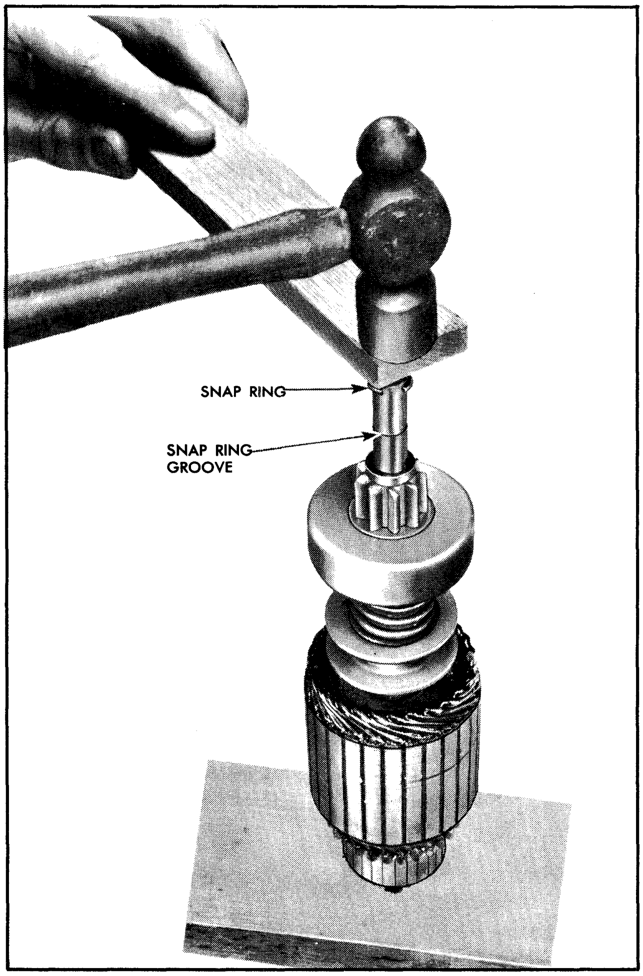



Fig. 11-14 Forcing Snap Ring Onto Armature Shaft

e. Assemble thrust collar on shaft with shoulder next to snap ring (Fig. 11-15).

f. Place armature flat on work bench, and position retainer and thrust collar next to snap ring. Then, using two pairs of pliers at the same time (one pair on either side of shaft), grip retainer and thrust collar and squeeze until retainer is forced over snap ring (Fig. 11-15).

2. Place 4 or 5 drops of light engine oil in drive housing bushing. Make sure thrust collar is in place against snap ring and retainer. Slide armature and clutch assembly into place in drive housing, engaging shift lever with clutch.

3. Position field frame over armature, and apply sealing compound between frame and solenoid case.

Position frame against drive housing, using care to prevent damage to brushes.

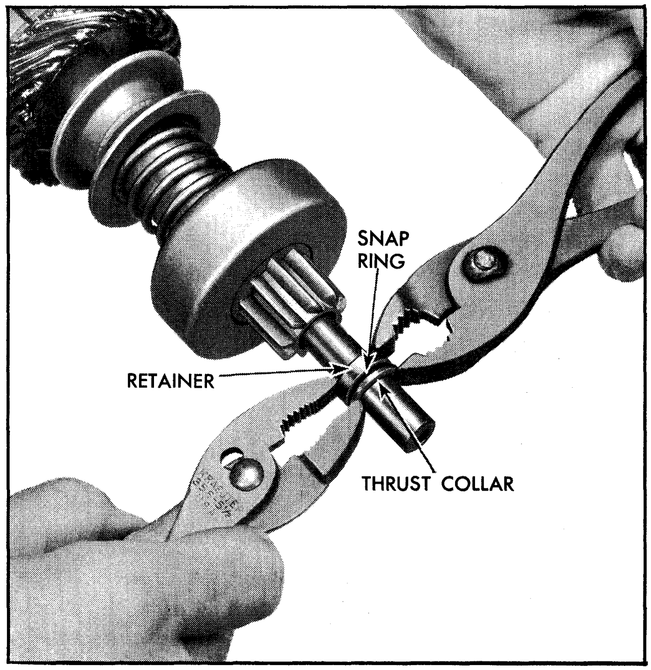



Fig. 11-15 Forcing Retainer Over Snap Ring

4. Place 4 or 5 drops of light engine oil in bushing in commutator end frame. Place leather thrust washer on armature shaft and slide commutator end frame onto shaft.

5. Install through bolts and tighten securely.

6. Reconnect the field coil lead to the motor solenoid terminal.

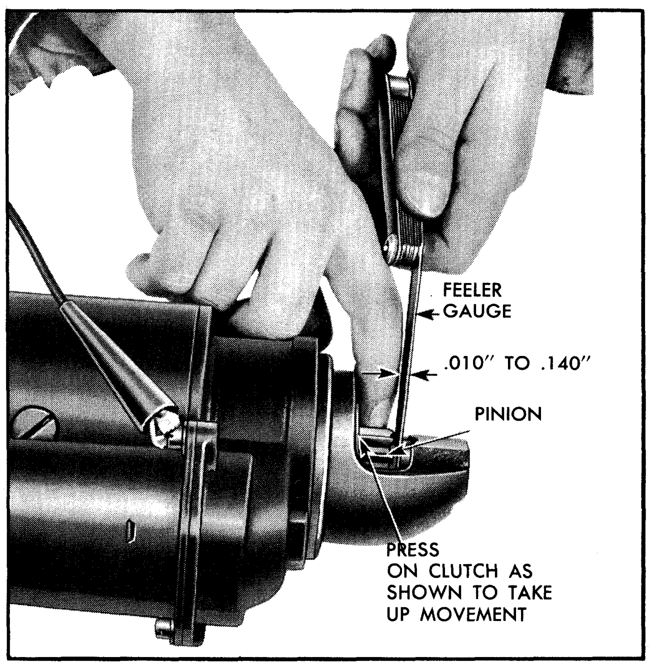



Fig. 11-16 Measuring Pinion Clearance

### PINION CLEARANCE CHECK

There are not provisions for adjusting pinion clearance on the enclosed shift lever cranking motor. When the shift lever mechanism is correctly assembled, the pinion clearance should fall within the specified limits (.010"-.140"). When the clearance is out of these limits it may indicate excessive wear of solenoid linkage or shift lever yoke buttons.

The pinion clearance should be checked after motor has been disassembled and then reassembled. To check, connect a voltage source of approximately 6 volts (three battery cells in series of 6-volt battery) between the solenoid switch terminal and ground.

*NOTE: Do not connect the voltage source to the ignition coil terminal "R" of the solenoid. Do not use a 12-volt battery instead of the 6 volts specified as this will cause the motor to operate. As a further precaution to prevent motoring, connect a heavy jumper lead from the solenoid motor terminal to ground. After energizing the solenoid with the clutch shifted towards the pinion stop retainer, push the pinion back toward the commutator end as far as possible to take up any slack movement, then check clearance with a feeler gauge (Fig. 11-16).*

### INSTALL IN CAR

1. Install starting motor.

2. Connect battery positive cable and wiring harness leads to starting motor solenoid.

3. Connect battery ground cable at battery terminal post.

### TROUBLE DIAGNOSIS

*CAUTION: Specific gravity of battery must be 1.215 or higher before making the following tests:*

1. If the solenoid does not pull in, measure the voltage between the switch S terminal of the solenoid and ground with the starting switch closed.

*CAUTION: If the solenoid feels warm, allow to cool before checking. If the voltage is less than 7.7 volts, check for excessive resistance in the solenoid control circuit. If the voltage exceeds 7.7 volts, remove the starting motor and check (1) solenoid current draw, (2) starting motor pinion clearance, and (3) freedom of shift lever linkage.*

2. If the solenoid "chatters" but does not hold in, check the solenoid for an open "hold-in" winding.

3. If motor engages but does not crank or cranks slowly, check for excessive resistance in the external cranking circuit or within the starting motor.

# CHARGING CIRCUIT

The charging circuit consists of the generator, voltage regulator, battery and ammeter (for a complete discussion on the battery see "Starting Circuit").

## GENERATOR

### DESCRIPTION

A 37 amp generator is used as standard equipment on the 6 and 8 cylinder engine cars. A 42 amp generator is used on cars equipped with air conditioning.

The generator produces alternating current which is converted to direct current through the use of six silicon diodes mounted within the generator.

It has the advantage of developing a continuous supply of current (up to 19 amps at idle), lighter weight, promoting longer battery and brush life, needing no periodic lubrication, and limiting its own current output (which eliminates the need for a current regulator). Brush life is increased due to low field current in rotor, nonsegmented slip rings, and no arcing. Also, no cut-out relay is needed in the regulator, since the one-way diodes in the generator protect it from the battery.

In addition to the diodes, the main components of the generator are the slip ring end frame, the drive end frame, the stator and the rotor (Fig. 11-17).

END FRAMES

The slip ring end frame houses the diodes and the brush assembly. The drive end frame retains the rotor assembly, fan and pulley. The stator assembly is sandwiched between the two end frames.

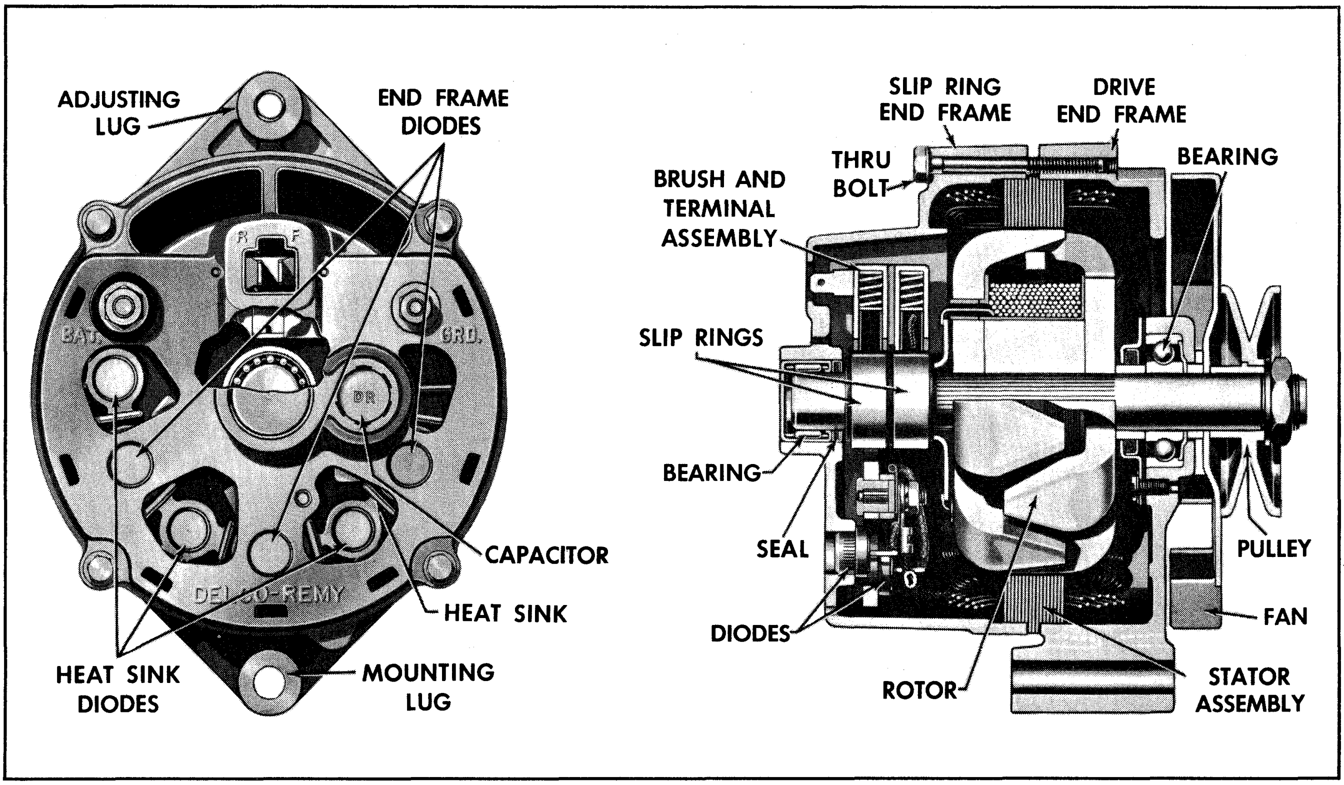



Fig. 11-17 Cross Section of Generator

STATOR

The stator assembly is made up of a laminated iron frame and a stator or output winding which is wound into slots of the frame. Each of the three windings is connected to the other two at one end and have two diodes connected to the other end.

ROTOR

The rotor assembly consists of a doughnut shaped field coil mounted between two iron segments with 14 interlacing fingers which make up the north and south poles. It is held together on the shaft by a press fit and rotates inside the stator assembly.

The rotor shaft is supported by prelubricated ball bearings in the drive end frame and a prelubricated roller bearing in the slip ring end frame.

Two slip rings, upon which the brushes ride, are mounted on one end of the rotor shaft and are attached to the leads from the field coil.

DIODES

The function of a diode is to permit current to flow in only one direction and to block it from flowing in the opposite direction. Therefore, the alternating current induced in the stator windings will appear as direct current at the output or "BAT" terminal of the generator.

However, since the diodes permit current to flow in only one direction, no current will flow from the battery through the generator to ground.

Three negative diodes are pressed into the slip ring end frame. Three positive diodes are pressed into a "heat sink" which is insulated from the slip ring end frame.

***OPERATING PRINCIPLES***

When the ignition switch is turned "on", current flows from the battery through the ignition switch, through the lower contact points of the voltage regulator and to the field terminal of the generator. Low field current then flows through one brush, through the slip ring upon which it rides and through the field coil in the rotor. After leaving the field coil, it flows through the other slip ring and brush to ground. Thus, this current energizes the field coil. With the engine running, the 14 pole rotor creates a spinning magnetic field whose lines of

force cut through the stationary stator windings, inducing alternating current in the stator windings.

The diodes convert the alternating current into direct current at the battery terminal. The diodes also prevent the battery from discharging through the generator.

*NOTE: Since the rotor poles have practically no residual magnetism, the field windings must be energized before the generator will produce any current. This current is supplied by the battery when the ignition switch is turned on. Since the generator does not have a permanent magnet, it is not necessary to polarize it.*

### PERIODIC SERVICE

The generator does not require periodic lubrication. The rotor shaft is mounted on ball bearings at the drive end, and a roller bearing at the slip ring end, and each has a permanent grease supply which eliminates the need for periodic lubrication. At periodic intervals, check the mounting bolts for tightness and the belt for proper alignment, wear and tension.

*CAUTION: When applying belt tension, apply pressure at center of generator, never against either end frame.*

### SERVICE PRECAUTIONS

Since the generator and regulator are designed for use on only one polarity system (negative ground) the following precautions must be observed when working on the charging circuit. Failure to observe these precautions will result in serious damage to the electrical equipment.

1. Do not attempt to polarize the generator. It isn't necessary since there are no permanent magnets.

2. Do not short across or ground any of the terminals on the generator.

3. Never operate the generator on an open circuit (with the field terminal connected and the output terminal disconnected). Make absolutely certain all connections in the circuit are secure. If the generator is operating on an open circuit, extremely high voltages may result that are both dangerous and damaging to the generator.

4. When installing a battery, always make absolutely sure the negative post of the battery is attached to the ground strap.

*CAUTION: Never reverse battery leads, even for an instant, as reverse polarity current flow will damage diodes in generator.*

5. When connecting a booster battery, make certain to connect the negative battery terminals together and the positive battery terminals together.

6. When connecting a charger to the battery, connect the charger positive lead to the battery positive terminal and the charger negative lead to the battery negative terminal.

### CHECK IN CAR

If the electrical system is not charging properly, follow the in-car checks outlined under "Standard Generator Regulator", prior to removing the generator. If electrical system trouble is found to be in the generator, it need not be removed from the car unless the drive end frame needs servicing, because the slip ring end frame separates from the drive end frame by simply loosening drive belt and removing four through bolts. If the drive end frames must be serviced, remove generator as follows.

### REMOVE FROM CAR

1. Disconnect positive battery terminal.

*CAUTION: Failure to observe this step may result in an injury from hot battery lead at generator.*

2. Remove two leads at generator.

3. Loosen adjusting bolts.

4. Remove alternator drive belt.

*CAUTION: To prevent damage to belt, it should be removed in the following sequence: 1 - from water pump pulley; 2 - from crankshaft pulley; 3 - from generator pulley.*

5. Remove the bolts which retain generator.

6. Remove generator from car.

### DISASSEMBLE GENERATOR

1. If rotor, drive end frame bearings, or pulley and fan need replacement, remove and replace the

shaft nut using strap wrench J-9183 around the fan assembly.

*NOTE: If the nut should happen to be cross-threaded or rusted and unusually difficult to remove, an alternate procedure is to use the strap wrench J-8183 around the rotor. The torque on the nut is 50-60 lb. ft.*

2. Scribe a mark between the two halves of the generator to help locate the parts in the same position during assembly.

3. Remove four through bolts.

4. Separate the drive end frame and the rotor assembly from the stator assembly by prying apart with a screwdriver at stator slot. The fit between the two is not tight and the two can be separated easily.

*NOTE: The separation is to be made between the stator assembly and Drive End Frame.*

*CAUTION: As the rotor and drive end frame assembly is separated from the slip ring frame assembly, the brushes will fall down onto the shaft and come in contact with the lubricant. Brushes which come in contact with shaft should be cleaned immediately to avoid contamination by oil, or they will have to be replaced.*

## ROTOR

The rotor may be checked electrically for grounded, open or short-circuited field coils as follows:

1. To check for grounds, connect a 110 volt test lamp or an ohmmeter from either slip ring to the rotor shaft, or to the rotor poles. If the lamp lights or the ohmmeter reading is low, the field winding is grounded (Fig. 11-18).

2. To check for opens, connect the test lamp or ohmmeter to each slip ring. If the lamp fails to light, or if the ohmmeter reading is high (infinite), the winding is open (Fig. 11-18).

3. The winding is checked for short-circuits by connecting a battery and ammeter in series with the two slip rings. The field current at 12 volts and 80°F. should be between 1.9-2.3 amperes. An ammeter reading above this value indicates shorted windings.

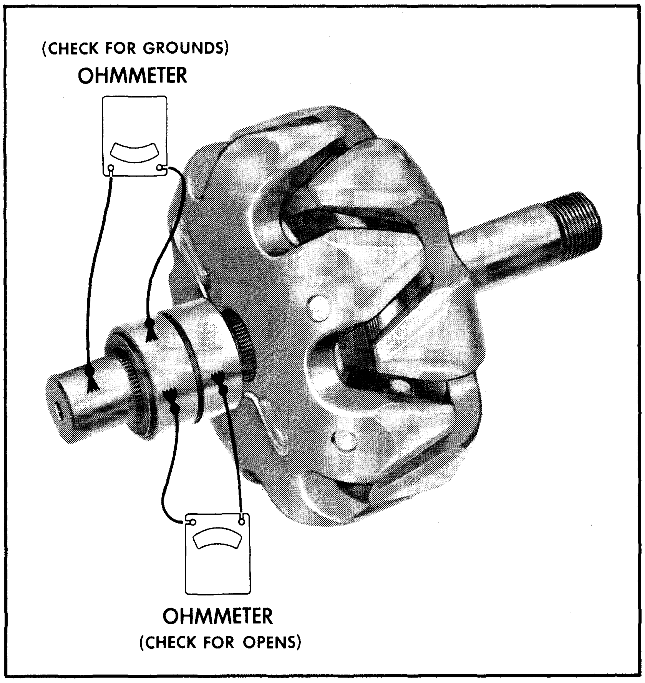



Fig. 11-18 Checking Rotor

4. Rotor assemblies which fail above tests should be replaced.

The rotor may be cleaned and inspected as follows:

a. If the magnetic poles of the rotor need cleaning, they may be cleaned by brushing with oleum spirits.

*CAUTION: Do not clean with degreasing solvent.*

b. Inspect slip rings for dirt and roughness. These may be cleaned with a solvent, if necessary. They may also be cleaned and finished with 400 grain or finer polishing cloth. Do not use sand paper. Spin the rotor in a lathe, or otherwise spin the rotor, and hold the polishing cloth against the slip rings until they are clean.

*CAUTION: The rotor must be rotated in order that the slip rings will be cleaned evenly. Cleaning the slip rings by hand, without spinning the rotor, may result in flat spots on the slip rings, causing brush noise.*

Slip rings which are rough or out of round should be trued in a lathe to .002" maximum indicator reading. Remove only enough material to make the rings smooth and round. Finish with 400 grain or finer polishing cloth and blow away all dust.

### DRIVE END FRAME BEARING

1. Remove three screws from retainer plate and remove retainer plate inner collar and gasket.

2. Press out bearing and oil slinger.

3. The bearings in a generator are permanently lubricated and require no lubrication during the life of the bearing. If a dry bearing is encountered, do not attempt to lubricate, as an improper lubricant, or an excessive amount of lubricant may burn bearing, or be thrown off and contaminate the inside of generator. Replace dry, worn, or rough bearings with a new bearing which will be prepacked with proper amount and type of lubricant.

4. To install, press in bearing and grease slinger with a tube or collar that just fits over the outer race.

5. Install retainer plate gasket and inner collar with three screws. It is recommended that a new retainer plate be installed if the felt seal is hardened or excessively worn.

### STATOR

If the stator is to be checked and/or replaced:

1. Remove 3 stator lead attaching nuts and washers (Fig. 11-19).

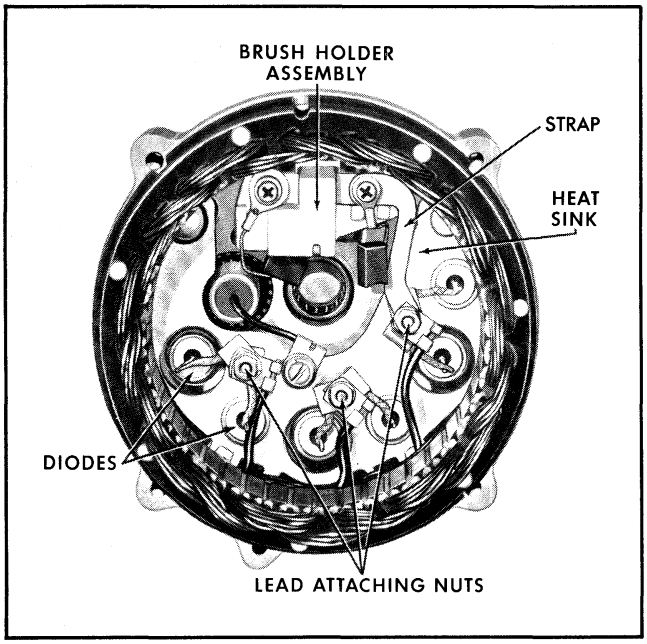



Fig. 11-19 Slip Ring Eng. Frame

2. Separate the stator assembly from the end frame. The fit between stator frame and end frame is not tight, and the two can be separated easily.

3. The stator windings may be checked with a 110 volt test lamp or an ohmmeter as follows:

a. To check for grounded windings, connect lamp or ohmmeter from any stator lead to frame. If lamp lights or ohmmeter reading is low the stator is grounded (see Fig. 11-20).

b. To test for opens, successively connect 110 volt test lamp or an ohmmeter between stator leads. If lamp fails to light and if ohmmeter reading is high, there is an open in the stator windings (see Fig. 11-20).

c. A short circuit in the stator windings is difficult to locate without laboratory test equipment, due to low resistance of the windings. However, if all other electrical checks are normal and the alternator fails to supply rated output, shorted stator windings are indicated.

d. Stator assemblies which fail above test should be replaced.

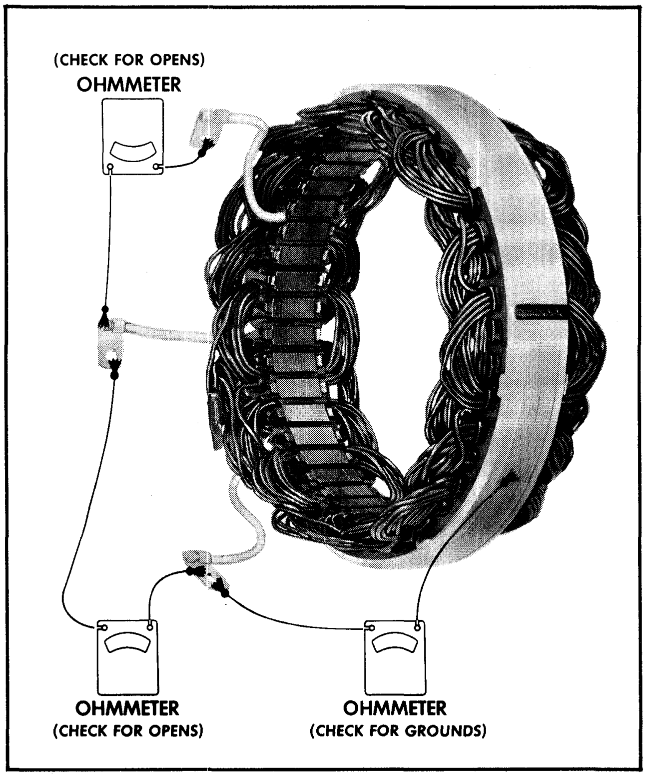



Fig. 11-20 Checking Stator

4. If necessary, stator assembly may be cleaned by brushing with oleum spirits.

*CAUTION: Do not clean in solvent.*

5. The stator can be installed by reversing steps 1 and 2.

### BRUSHES

1. Remove two brush holder screws and stator lead to strap attaching nut and washer (Fig. 11-19).

Remove brush holder assembly and brushes. Carefully note stack-up of parts (Fig. 11-21) for reassembly.

3. Inspect brush spring for evidence of damage or corrosion.

4. Inspect brushes for wear or contamination.

5. If old brushes are to be reused, they must be thoroughly cleaned with a soft dry cloth and must be completely free of oil.

6. If there is any doubt about condition of brush springs, they should be replaced.

7. Install the spring and brushes into the brush holder (they should slide in and out without binding). Insert a straight wood or plastic toothpick (to prevent scratching brush face) into the hole at the bottom of the holder to retain the brushes.

8. Attach the brush holder assembly into the end frame, noting carefully the stack-up of parts as shown in Fig. 11-21. Allow the wood or toothpick to protrude through the hole in the end frame and install stator lead to strap attaching nut and washer (Fig. 11-21).

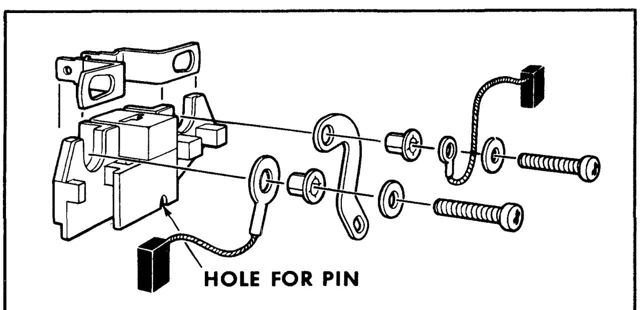



Fig. 11-21 Brush Holder Assembly

### SLIP RING END FRAME BEARING AND SEAL

1. With stator removed, press out bearing and seal with a tube or collar that just fits inside the end frame housing. Press from the outside of the housing toward the inside. Support inside of frame with hollow cylinder to allow seal and bearing to pass through.

2. The bearings in a generator are permanently lubricated and require no lubrication during the life of the bearing. If a dry bearing is encountered, do not attempt to lubricate, as an improper lubricant, or an excessive amount of lubricant may burn bearing, or be thrown off and contaminate the inside of generator. Replace dry, worn, or rough bearings with a new bearing which will be prepacked with proper amount and type of lubricant.

3. Place a flat plate over the bearing and press in from outside toward the inside of frame until the bearing is flush with the outside of the end frame. Support the inside of frame with a hollow cylinder to prevent breakage of the end frame. Use extreme care to avoid misalignment or otherwise placing undue stress on the bearing.

4. From inside of frame, insert seal flush against bearing.

5. Install stator and connect leads.

### DIODES

Diodes are checked by making use of their principles of allowing electricity to pass through in only one direction. Two methods are available:

#### OHMMETER METHOD

The lowest range scale on the ohmmeter should be used, and it should have a 1-1/2 volt cell. To determine the cell voltage, turn the selector to the lowest scale, and then connect the ohmmeter leads to a voltmeter. The voltmeter will indicate cell voltage.

HEAT SINK DIODES:

1. With the stator disconnected, check a diode in the heat sink by connecting one of the ohmmeter leads to the heat sink, and the other ohmmeter lead to the diode lead and note reading, (see Fig. 11-22).

2. Reverse ohmmeter leads and note reading.

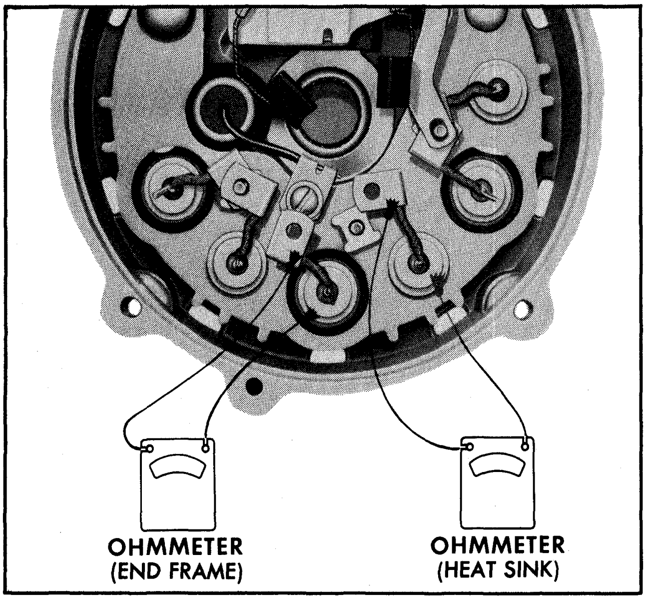



Fig. 11-22 Checking Diodes

3. If both readings are very low or very high (read the same), the diode is defective. A good diode will give one low reading and one high reading.

4. Check the other two diodes in the heat sink in the same manner.

End Frame Diodes:

1. To check a diode mounted in the end frame, connect one of the ohmmeter leads to the end frame and the other ohmmeter lead to the diode lead and note reading (see Fig. 11-22).

2. Reverse ohmmeter leads and note readings.

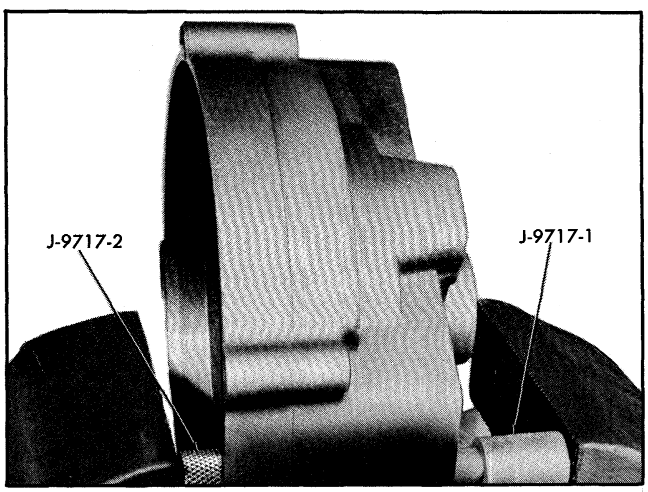



Fig. 11-23 Removing Diode

3. If both readings are very low or very high (read the same), the diode is defective. A good diode will give one low reading and one high reading.

4. Check the other two diodes in the end frame in the same manner.

TEST LAMP METHOD

An alternate method of checking diodes is to use a test lamp of not more than 12 volts in place of the ohmmeter.

*CAUTION: Do not use 110 volt test lamp to check diodes.*

With the stator disconnected, connect the test lamp across each diode as previously described, first in one direction and then the other.

If the lamp lights in both checks, or fails to light in both checks, the diode is defective. When checking a good diode, the lamp will light in only one of the two checks.

Diodes which fail the electrical tests should be replaced. If diode must be replaced:

1. With stator removed, support slip ring end frame in vise or arbor press with J-0717-2 against casting and position remover J-9717-1 against diode as shown in Fig. 11-23.

2. Tighten vise to remove diode.

*CAUTION: Never attempt to remove diode by striking it, as the shock may damage the other diodes.*

3. To install a diode, place a new diode in installer J-9600-2.

4. Place slip ring end frame in a vise so that new diode is in position and remover J-9717-1 supports casting (Fig. 11-24).

5. Tighten vise to install diode.

*CAUTION: Never attempt to install diode by striking it, as the shock may damage the other diodes.*

6. Install stator and connect leads.

***HEAT SINK ASSEMBLY***

*NOTE: Do not disassemble unless absolutely necessary. The heat sink must be completely insulated from end frame.*

1. With stator removed, remove screw retaining condenser lock washer, flat washer, fiber insulator and condenser lead.

2. Remove "BAT" and "GRID" terminals and respective washers and insulators from end frame.

3. Remove heat sink and washers.

4. Replace heat sink assembly, noting the stack-up of parts shown in Fig. 11-25.

5. Attach condenser lead to heat sink with washer and screws. Be sure insulating washer is between heat sink and end frame.

6. Install stator and connect leads.

### ASSEMBLE GENERATOR

1. Before assembling rotor and drive end frame to slip ring end frame, make sure the bearing surfaces of the shaft are perfectly clean.

2. Join together two end frames, matching scribe marks.

3. Install four through bolts.

4. Remove wood or toothpick from brush holder assembly.

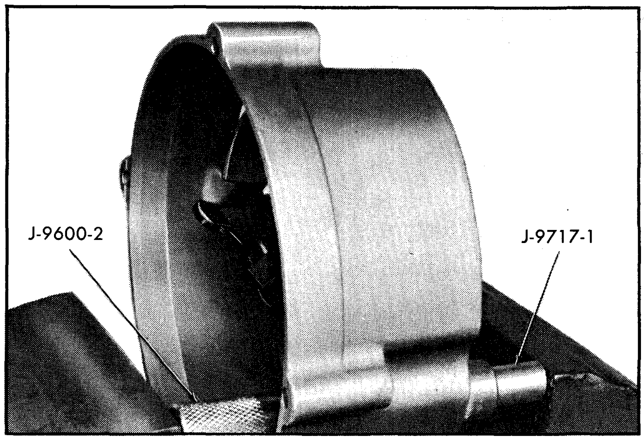



Fig. 11-24 Installing Diode

### INSTALL IN CAR

1. If removed from car, install generator to mounting bracket with bolts, washers, and nuts. Do Not Tighten.

2. Install generator drive belt.

*CAUTION: To prevent damage to belt it should be installed in the following sequence: 1 - in generator pulley groove; 2 - in crankshaft pulley groove; 3 - in water pump pulley groove.*

3. On all but air conditioned cars, exert a force on generator using J-21268. On air conditioned cars use a lever between mounting bracket and timing chain cover. Adjust belt tension.

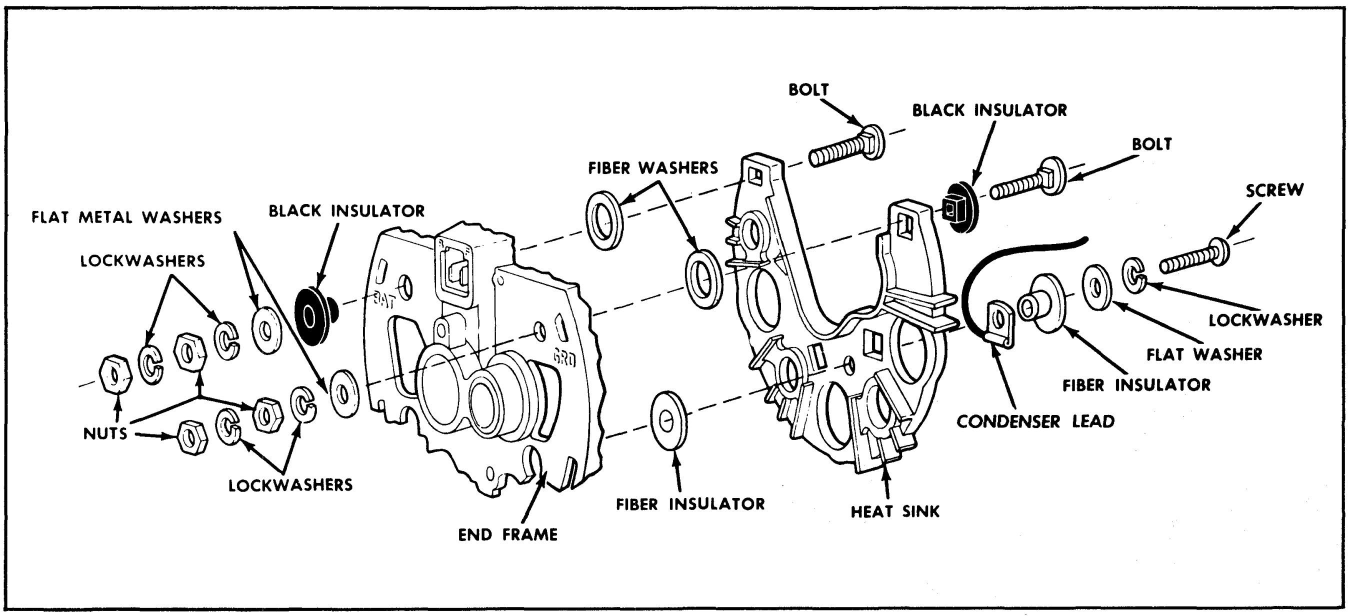



Fig. 11-25 Heat Sink Assembly

4. Tighten bolts to 25-35 lb. ft., except bolt at sliding slot on bracked used for other than air conditioned cars, which is 10-25 lb. ft.

5. Install field and battery leads to generator.

6. Connect positive battery terminal.

*CAUTION: Take care not to reverse polarity.*

### NOISY GENERATOR

Noise from a generator may be caused by a loose drive pulley, loose mounting bolts, worn or dirty bearings, a defective diode, out-of-round or rough slip rings, hardened brushes, or a defective stator.

## GENERATOR REGULATOR

### DESCRIPTION

A double contact voltage regulator unit and a field relay unit make up the regulator assembly (Fig. 11-26). The voltage regulator unit operates to limit the generator voltage to a pre-set value whereas the field relay connects the generator field winding and regulator winding directly to the battery. When the ignition switch is first turned on the charge indicator lamp lights. Then, when the generator begins to charge, the indicator lamp goes out, indicating the system is operating normally. If the lamp should come on when the generator is in operation, trouble in the system is indicated.

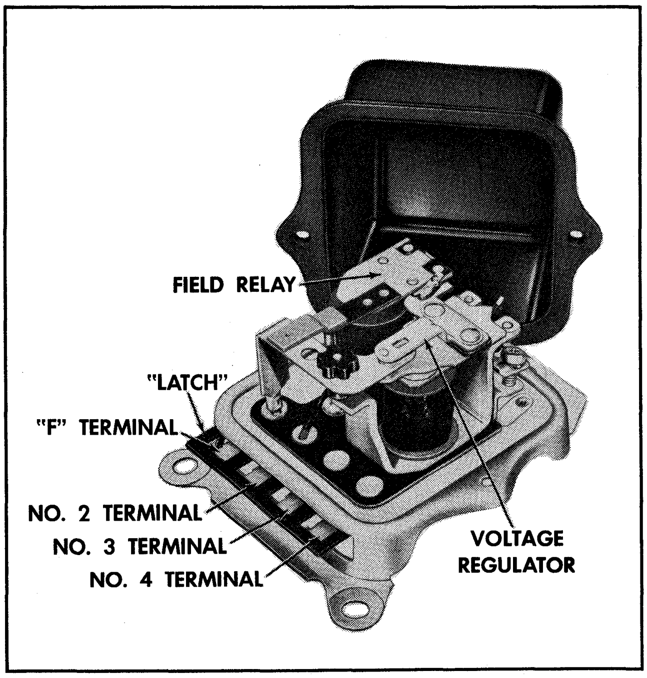



Fig. 11-26 Voltage Regulator

### OPERATING PRINCIPLES

Following is a brief description of the operating principles of the units in this type of circuit (Fig. 11-27).

When the ignition switch is closed, before the engine has started, the indicator lamp lights to indicate the generator is not charging. The current flow can be traced from the battery to the "BAT" terminal on the switch, through the indicator lamp and resistor which is in parallel, and then through the voltage regulator contacts. From here it continues to flow on through the generator field winding to ground, completing the circuit back to the battery. Current through this circuit energizes the field windings sufficiently to insure voltage build-up in the stator windings when the engine starts. The voltages generated in the stator windings are then changed or rectified by the six generator diodes to a d.c. voltage which appears at the "BAT" or output terminal on the generator. The resistor allows more current to flow through the field windings to insure voltage build-up in the stator windings.

As the generator begins to operate, voltage from the "R" or relay terminal is impressed through the regulator No. 2 terminal across the field relay

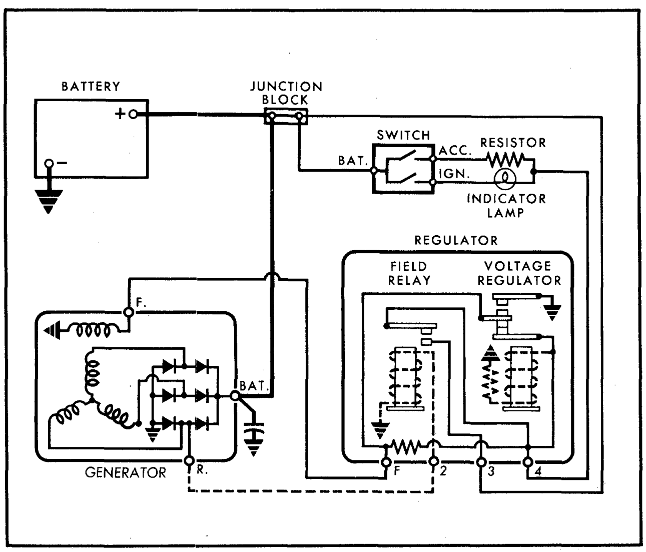



Fig. 11-27 Regulator in Charging Circuit

winding, causing the relay contacts to close. This connects the regulator No. 4 terminal directly to the battery through the field relay contacts, causing the indicator lamp to go out. Generator field current then flows from the battery to the regulator No. 3 terminal, and then through the field relay contacts and voltage regulator lower or series contacts to the field winding.

As the speed of the generator increases, the voltage at the "BAT" terminal of the generator also increases. This impresses a higher voltage through the field relay contacts and across the voltage regulator shunt windings. This increased magnetism created by this higher voltage across the winding causes the lower or series contacts of the relay to separate. The field current then flows through a resistor which reduces the field current. This reduced field current causes the generator voltage to decrease thereby decreasing the magnetic pull of the voltage regulator shunt winding. Consequently the spring causes the contacts to reclose. This cycle repeats many times per second to limit the generator voltage to a pre-set value.

As the generator speed increases even further, the resistor, connected across the contacts, is not of sufficiently high value to maintain voltage control on the contacts. Therefore the voltage increases slightly causing the upper or "shorting" contacts to close. When this happens, the generator field winding is shorted and no current passes through the winding. With no current in the field winding, the generator voltage decreases, which also decreases the magnetism in the shunt winding and the upper contact points open. With these points open, field current flows through the resistor and the field winding. As the voltage increases, the contacts reclose. This cycle then repeats many times per second to limit the generator voltage to a pre-set value at high generator speeds. The voltage regulator unit thus operates to limit the value of generator voltage throughout the generator speed range. Consequently the electrical accessories are protected from excessive voltage which would cause damage.

### *PERIODIC SERVICE*

Normally periodic service of the regulator is not required. However, it may occasionally be necessary to clean and adjust the regulator contact points, adjust air gap and tailor voltage setting according to type of driver and climatic conditions.

### *CHECK AND ADJUST ON CAR*

#### CHARGING SYSTEM TESTS

Any malfunction of the charging system will eventually result in:

Faulty indicator lamp operation.

An undercharged battery as evidenced by slow cranking.

An overcharged battery as evidenced by excessive water usage.

The following precautions must be observed when working on the charging circuit. Failure to observe these precautions will result in serious damage to the electrical equipment.

A. Do not polarize the generator.

B. Do not short across or ground any of the terminals on the generator or regulator.

C. Never operate the generator on open circuit. Make absolutely certain all connections in the circuit are secure.

D. Since the generator and regulator are designed for only one polarity system; always make absolutely sure the ground polarity of the battery and the ground polarity of the generator are the same when installing a battery.

E. When connecting a booster battery, make certain to connect the negative battery terminals together and the positive battery terminals together.

F. When connecting a charger to the battery, connect the charger positive lead to the battery positive terminal and the charger negative lead to the battery negative terminal.

Before making any electrical checks, visually inspect all connections, including the slip-on connectors at the regulator and generator to make sure they are clean and tight, then proceed. Since the regulator terminals are of the slip-on type, a special cable assembly or adapter must be used during testing so that meter connections can be make to the terminals. Such an adapter is available from the various test equipment manufacturers and tool companies that supply equipment to the automotive field.

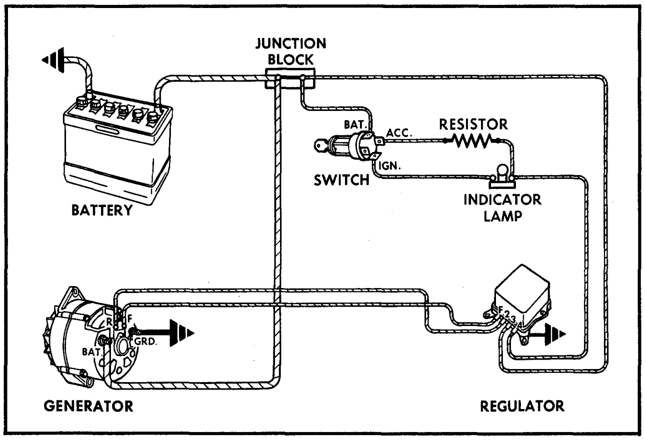



Fig. 11-28 Basic Lead Connections

*CAUTION: To check the charging system, insert the adapter into the regulator, making connections only as shown in the illustration (Fig. 11-28). Avoid contact with the units when replacing the regulator cover.*

INDICATOR LAMP CIRCUIT

The indicator lamp is a No. 57 bulb rated at 12 volt 2 candlepower. If the indicator lamp fails to light, turn the ignition switch to the "IGN" position, but do not start the engine. Momentarily (for not more than 10 seconds) connect a jumper lead from the adapter to ground as shown in Fig. 11-20. If the lamp does not come on, check for a burned out bulb, or an open in the wiring between the battery and the jumper lead. If the lamp comes on, connect the jumper as shown in Fig. 11-30. If the lamp comes on again, the circuit is open in the regulator. If it does not come on, there is an open in the field lead between the regulator and generator or in the generator field.

Failure of the lamp to go out with the generator in operation is an indication of trouble elsewhere in the system. The possible causes of this are covered

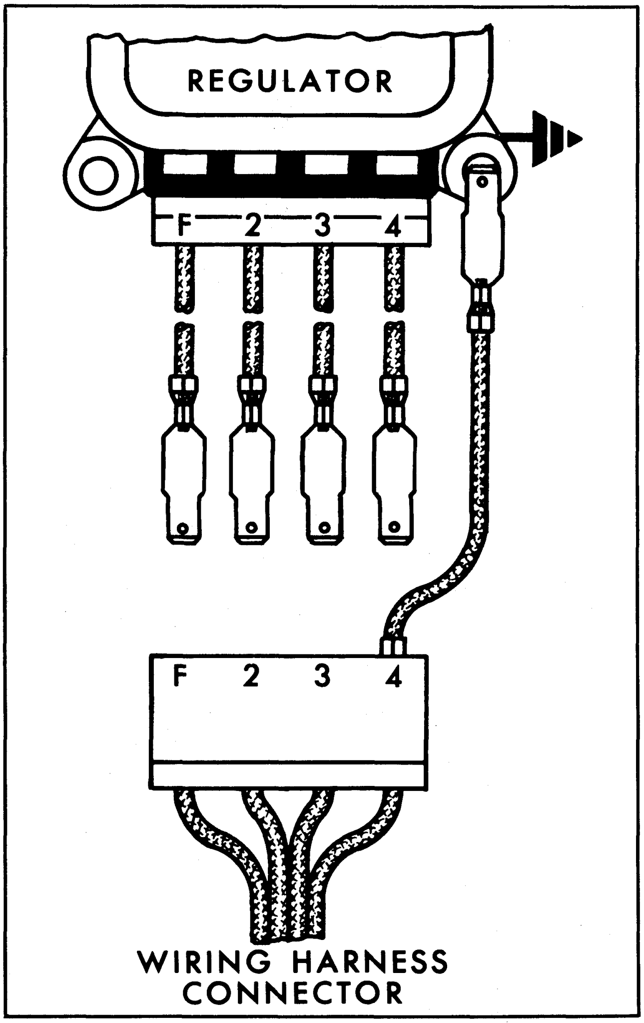



Fig. 11-29 Checking Indicator Lamp Circuit

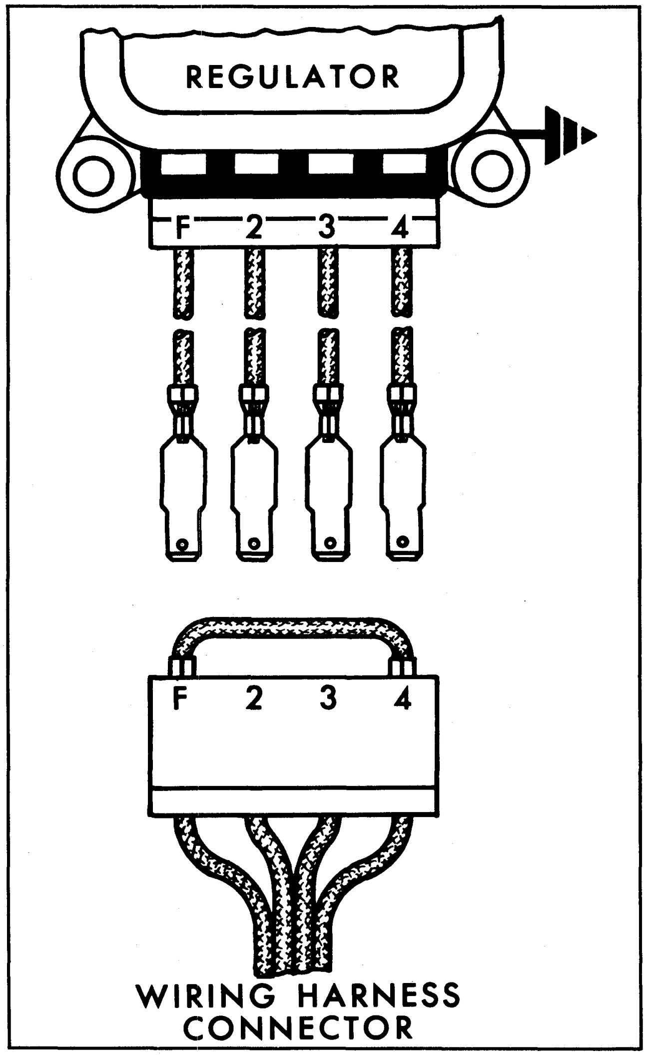



Fig. 11-30 Checking Indicator Lamp Circuit

under steps 1, 4, and 5 in "Undercharged Battery" section. Also, if the lamp fails to go out when the ignition switch is turned off, the generator probably has a shorted diode in the heat sink. The shorted diode will reduce the generator output and cause a discharged battery. Also, a discharged battery will occur overnight with the vehicle not operating, since the battery will discharge through the shorted diode and field winding even though the switch is turned off.

UNDERCHARGED BATTERY

This condition, as evidenced by slow cranking, can be caused by one or more of the following conditions even though the indicator lamp may be operating normally.

1. Loose Generator Drive Belt: The generator drive belt should be tightened to specification.

2. Defective Battery: A battery which is sulphated, or one with an intermittent "open" at either a terminal post or in one of the cell connectors, will remain in an undercharged condition under normal operating conditions.

3. Excessive Circuit Resistance: Visually inspect all connections to make sure they are clean and tight.

4. An Open Resistor: To check for an open resistor (connected to the ignition switch "ACC" terminal), connect a voltmeter from the adapter to ground as shown in Fig. 11-31. Turn the ignition switch to the "ACC only" position. If the voltmeter reads zero, the resistor is open. The resistor may be a separate unit, or it may be in the form of resistance wire. The resistance value is 10 ohm, and the wattage rating is 6.25 watts minimum, on many applications.

5. Malfunction of Field Relay: If the indicator lamp operates normally, the field relay is operating normally, and no further checks need be made on the field relay. However, if the indicator lamp fails to go out with the generator in operation, the fault may be in the field relay, or in the generator.

To determine which is at fault, proceed as follows:

a. Make connections to the adapter as shown in Fig. 11-32.

b. Operate the generator at moderate speed, and observe the voltmeter reading.

c. If the voltmeter reading is 5 volts or above, and the indicator lamp fails to go out, the field relay is defective and must be checked as covered in "Tests and Adjustments" section.

d. If the voltmeter reading is below 5 volts, trouble in the generator is indicated. Proceed to section entitled "Defective Generator."

6. Defective Generator: To determine if the generator is operating properly, proceed as follows:

a. Connect an ammeter in the circuit at the "BAT" terminal of the generator, and a voltmeter from the "BAT" terminal to ground.

b. Make connections to the adapter as shown in Fig. 11-33.

c. Turn on switch, operate generator at specified speed, and check for rated output.

*CAUTION: Load the battery with a carbon pile rheostat or accessories to prevent high voltage.*

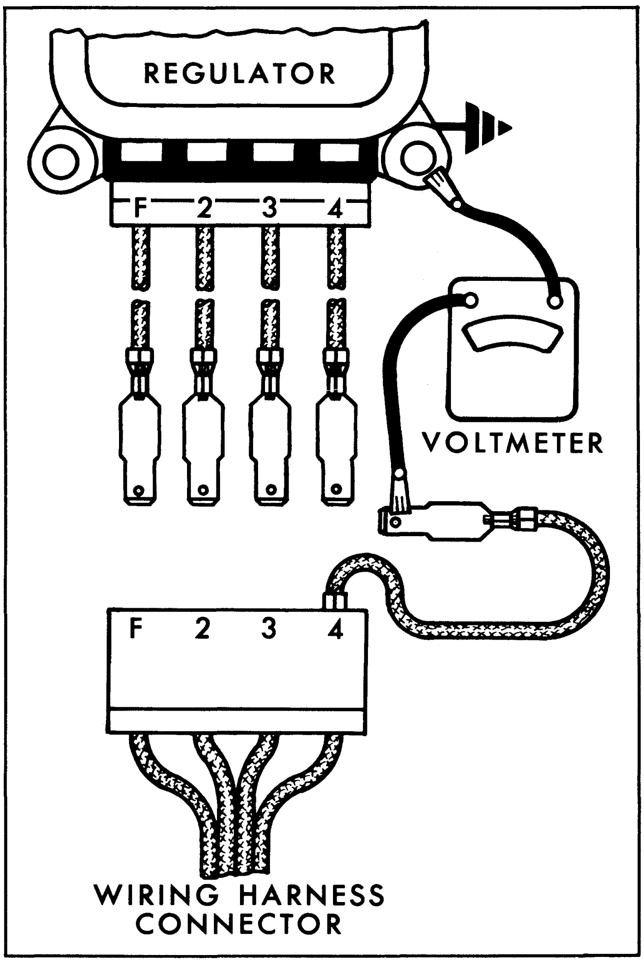



Fig. 11-31 Checking for Open Resistor

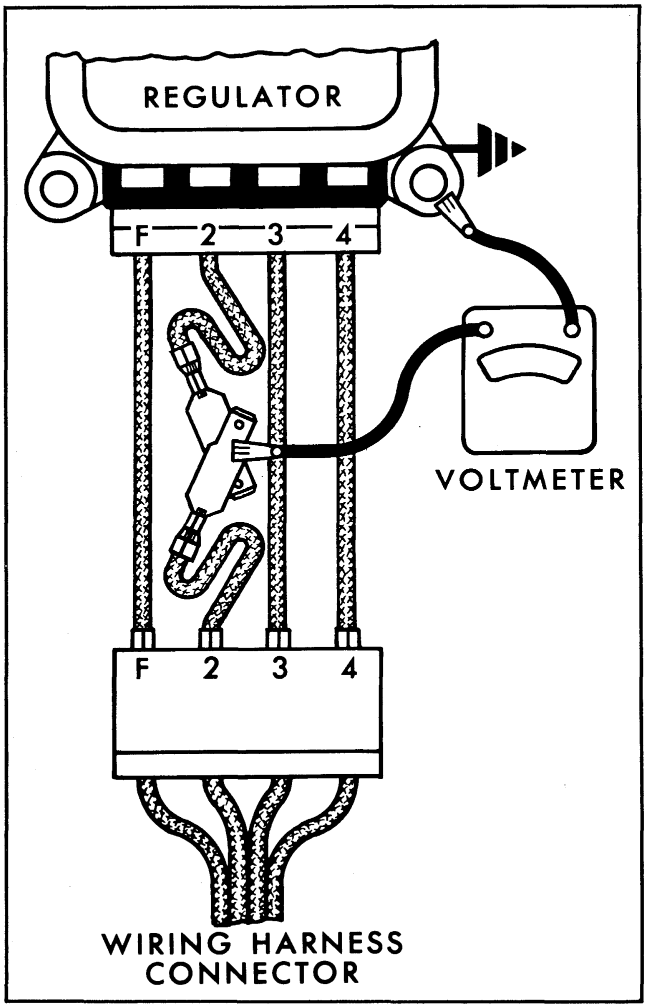



Fig. 11-32 Checking Field Relay

*Do not allow the generator voltage to exceed the recommended voltage setting of the regulator.*

If the generator does not provide rated output, it should be checked as covered in the generator section.

7. Low Voltage Regulator Setting: If no circuit defects are found, yet the battery remains undercharged, the cause most likely is a low voltage regulator setting. In this case, proceed to section entitled "Tailoring The Voltage Setting."

OVERCHARGED BATTERY

An overcharged battery as evidenced by excessive water usage, can be caused by:

1. A shorted battery cell.

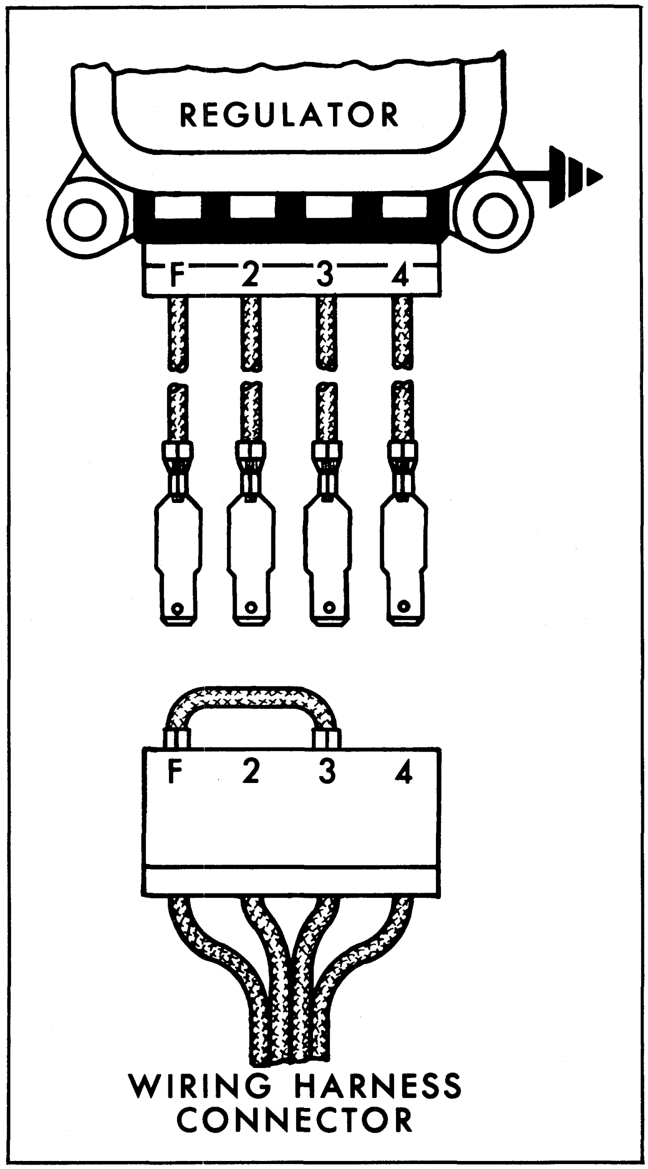



Fig. 11-33 Checking Generator Output

2. Excessive circuit resistance.

3. A high voltage regulator setting.

1. Shorted Battery Cell: Checks for shorted battery cells should be made as this can cause the battery to be overcharged.

2. Excessive Circuit Resistance: Visually inspect all connections to make sure they are clean and tight.

3. High Voltage Regulator Setting: If no circuit defects are found, yet the battery remains overcharged, the cause is probably a high voltage regulator setting. In this case, refer to "Tailoring The Voltage Setting."

TAILORING THE VOLTAGE SETTING

It is important to remember that the voltage setting for one type of operating condition may not be satisfactory for a different type of operating condition. Vehicle underhood temperatures, operating speeds, and nighttime service all are factors which help determine the proper voltage setting. The proper setting is attained when the battery remains fully charged with a minimum use of water.

If no circuit defects are found, yet the battery remains undercharged, raise the setting by .3 volt, and then check for an improved battery condition over a service period of reasonable length. If the battery remains overcharged, lower the setting by .3 volt, and then check for an improved battery condition. Recommended voltage setting procedures are covered in "Tests and Adjustments."

### *TESTS AND ADJUSTMENTS*

Regulator checks and adjustments are made as follows:

VOLTAGE REGULATOR UNIT

Three checks and adjustments are required on the voltage regulator unit: (1) point opening, (2) air gap, and (3) voltage setting. If the voltage can be properly adjusted the point opening and air gap need not be checked.

1. Point Opening: With the lower contacts touching, measure the point opening between the upper contacts as shown in Fig. 11-34. Adjust by bending the upper contact arm (Fig. 11-34), being careful not to bend the hinge (Adjust to .005").

2. Air Gap: Measure the air gap with a feeler gauge between the armature and core when the lower contacts are touching as shown in Fig. 11-35. To adjust the air gap, turn the nylon nut located on the contact support (Fig. 11-35). (Adjust to .057").

*NOTE: Only an approximate voltage regulator air gap setting should be made by the "feeler gauge" method. The final air gap setting must be whatever is required to obtain the specified difference in voltage between the upper and lower sets of contacts. This is covered in the next section.*

3. Voltage Setting: The voltage at which the regulator operates varies with changes in regulator

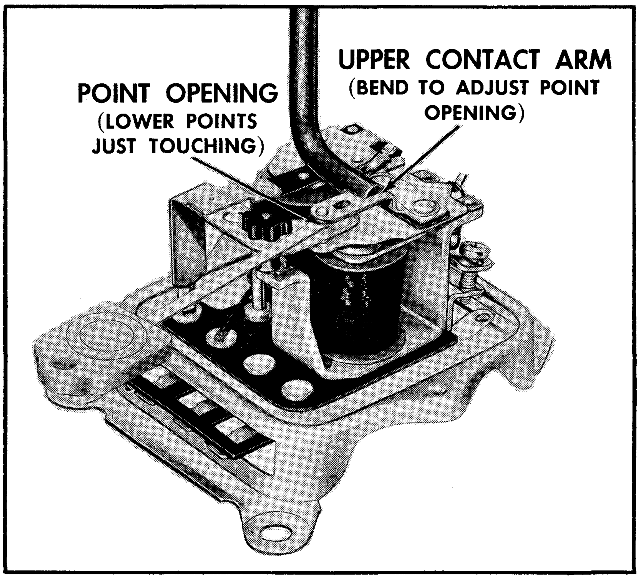



Fig. 11-34 Checking Point Opening

ambient temperatures. The ambient temperature is the temperature of the air measured 1/4 of an inch from the regulator cover. When checking and adjusting the voltage setting, always refer to Specifications at end of section.

To check and adjust the voltage setting, proceed as follows:

A. Connect an ammeter and a 1/4 ohm resistor with a rating of 25 watts or more in series in the circuit at the "BAT" terminal on the generator. (Fig. 11-36) In case the battery is discharged, the 1/4 ohm resistor will limit the generator output to 10 amperes or less which is required when checking and adjusting the voltage setting.

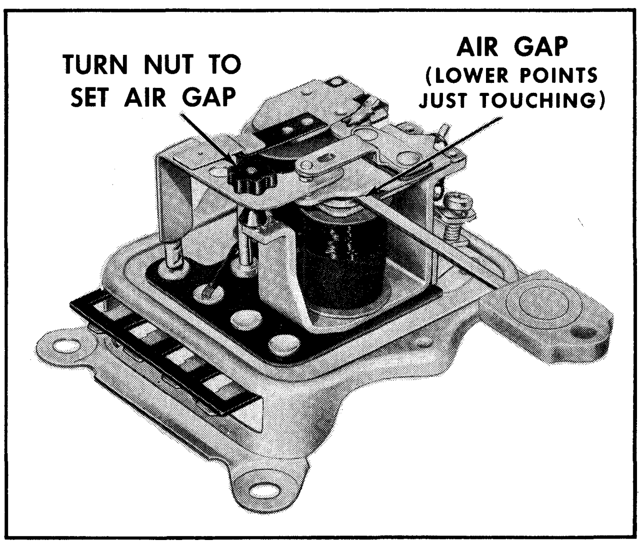



Fig. 11-35 Checking Air Gap

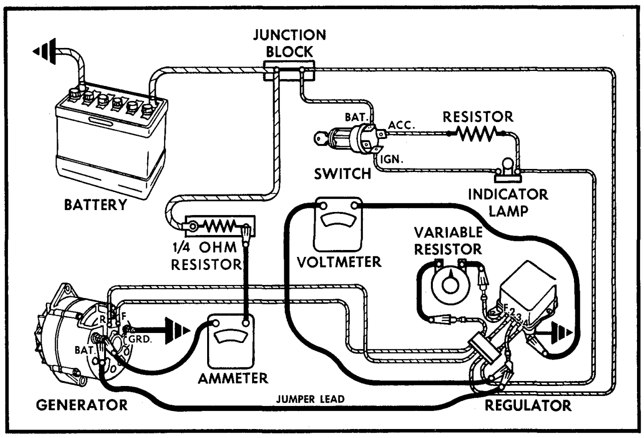



Fig. 11-36 Connections for Checking Voltage Setting

B. Make connections to the adapter as shown in Fig. 11-37. Use a 25 ohm 25 watt variable resistor in series with the generator field winding at the regulator "F" terminal, and connect a jumper lead from the adapter to the generator output or "BAT" terminal as shown. Also, connect a voltmeter from the adapter to ground, as shown. Turn the variable resistor to the closed or "no resistance" position.

C. Operate the generator for 15 minutes at approximately 1500 engine rpm (approximately 3500 generator rpm). Leave cover on regulator to establish operating temperature. Accessories and lights must be turned off.

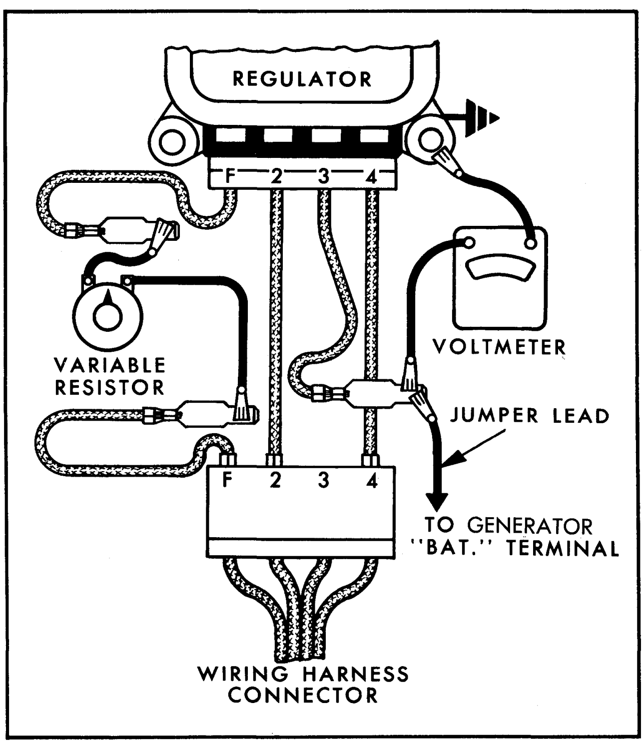



Fig. 11-37 Checking Voltage Setting

D. After the 15 minute warm-up period, cycle the regulator by the following procedure:

a. Turn the variable resistor in the field circuit to the "off" or full resistance position.

b. Disconnect the lead at the No. 4 terminal on the wiring harness connector.

c. Re-connect the lead at the No. 4 terminal on the wiring harness connector, and

d. Return the variable resistor to the closed or "no resistance" position.

e. Bring engine speed up to 2500 rpm (approximately 6000 generator rpm) and note the voltage setting (refer to Fig. 11-43). The regulator should be operating on the upper or shorting contacts. If it will not operate on the upper contacts, the battery is in an extreme state of discharge, and must be at least partially recharged before proceeding. The methods of identifying upper or lower contact operation are covered in step I.

E. To adjust voltage setting, turn adjusting screw as shown in Fig. 11-38. IMPORTANT: In order to prevent accidental grounding and consequent damage to internal regulator parts while removing cover or replacing cover always perform the following steps "a" through "e" in the order listed.

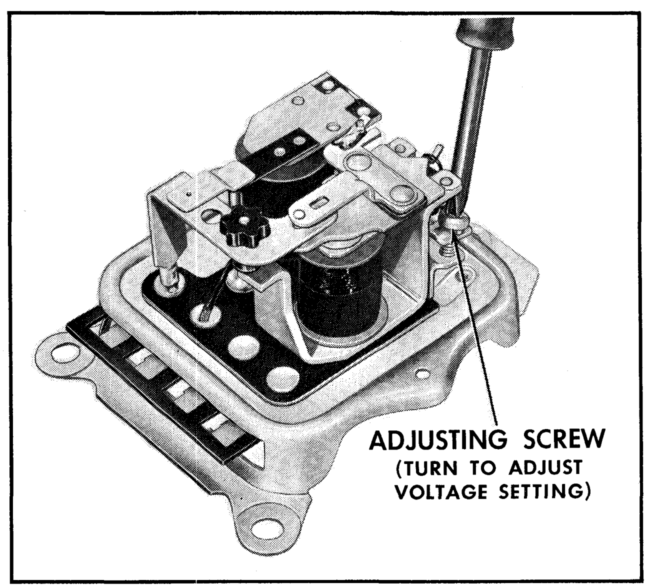



Fig. 11-38 Adjusting Voltage Setting

a. Disconnect regulator adapter No. 4 lead at wiring harness connector.

b. Disconnect jumper lead at generator "BAT" terminal.

c. Remove, or install, cover.

d. Reconnect jumper lead at generator "BAT" terminal.

e. Reconnect No. 4 lead at harness connector.

*CAUTION: Always turn screw clockwise to make final setting to insure springholder being against head of screw.*

F. After making the setting, cycle the regulator as covered in "Step D."

POINT OPENING

G. Then, operate at 2500 engine rpm (approximately 6000 generator rpm), and note setting. Re-adjust if necessary.

H. Always cycle the regulator as covered in "Step D" before reading the final voltage setting on the voltmeter. Always read final setting with cover in place.

I. After making voltage setting while operating on the upper set of contacts, check the voltage setting while operating on the lower set of contacts as follows: Slowly increase the resistance of the variable resistor with the engine operating at 2500 rpm (approximately 6000 generator rpm) until the regulator begins to operate on the lower set of contacts. Then note the voltage reading, and refer to Fig. 11-43. NOTE: If turning the variable resistor does not cause the regulator to operate on the lower set of contacts, return the variable resistor to the "no resistance" position, turn the carbon pile to slightly load the battery, and then adjust the variable resistor to cause the regulator to operate on the lower set of contacts. Usually, turning on the vehicle headlights can substitute for the carbon pile.

The most desirable method of determining that the regulator is operating on the lower set of contacts is to use earphones connected from the regulator "F" terminal to ground. As the variable resistor is turned, and operation changes from the upper set of contacts to the lower set, the earphone sound will fade away and stop completely and then return when the lower set of contacts begins to operate. The alternate method is to observe the voltmeter change from one value to another, but this is less desirable since it is not as accurate.

J. The difference in voltage between the operation of the upper set of contacts and the lower set is increased by slightly increasing the air gap between the armature and center of core and decreased by slightly decreasing the air gap. See Fig. 11-35 for changing the voltage regulator air gap. If it is found necessary to make this air gap adjustment, it will be necessary to recheck the voltage setting of both sets of contacts. Always read final voltage setting with cover in place.

FIELD RELAY UNIT

Three checks are required on the field relay: (1) air gap, (2) point opening, (3) closing voltage.

1. Air Gap: With the regulator removed from the vehicle, check the air gap with the points just touching as shown in Fig. 11-39. If adjustment is necessary, carefully bend the flat contact support spring.

2. Point Opening: Measure the opening between the points, and adjust by bending the armature stop. (Fig. 11-40).

3. Closing Voltage: The closing voltage of the field relay may be checked as follows:

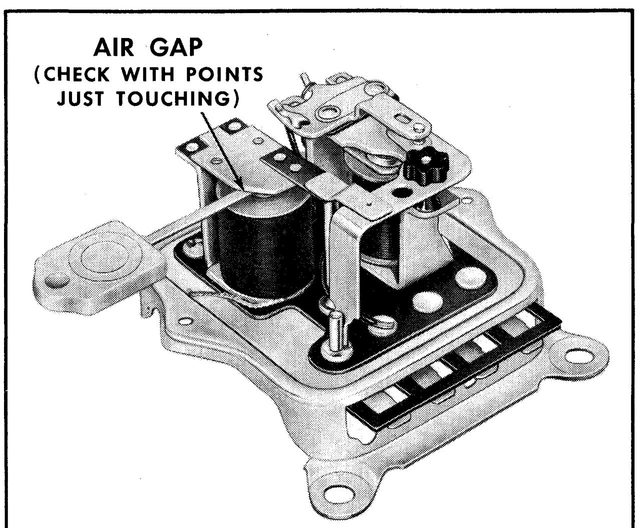



Fig. 11-39 Checking Field Relay Air Gap

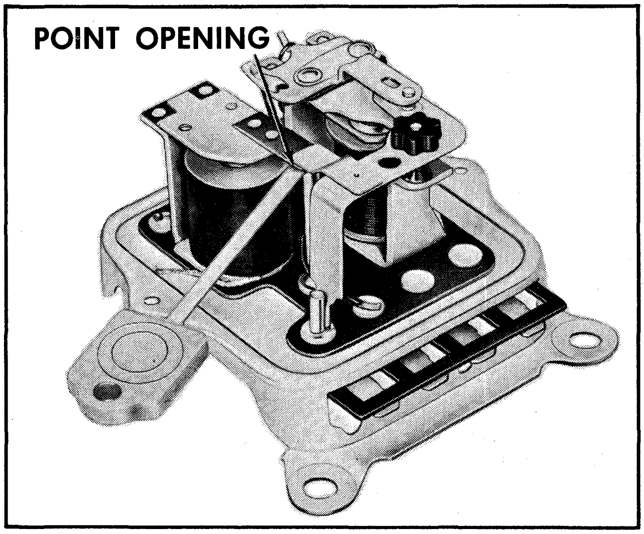



Fig. 11-40 Checking Field Relay Point Opening

A. Connect a 50-70 ohm variable resistor and a voltmeter to the adapter as shown in Fig. 11-41. Turn variable resistor to the open or "full resistance" position, and leave the ignition switch in the "off" position.

B. Slowly decrease resistance and note closing voltage of the relay. Adjust by bending heel iron in the manner illustrated in Fig. 11-42.

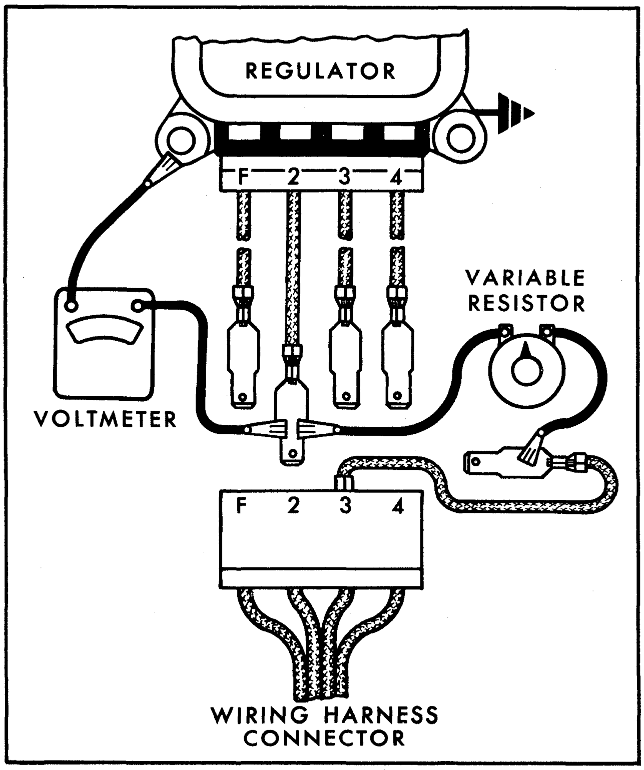



Fig. 11-41 Checking Field Relay Closing Voltage

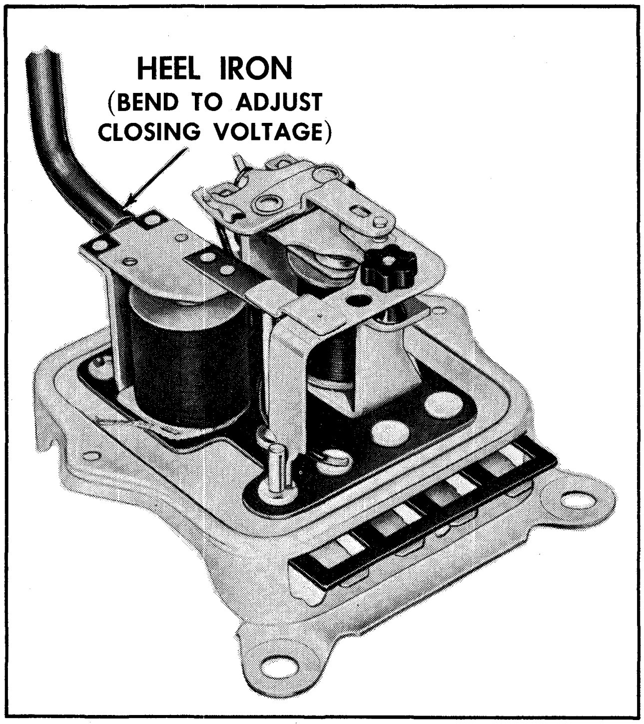



Fig. 11-42 Adjusting Field Relay Closing Voltage

*NOTE: If the field relay unit does not have an armature stop, a point opening check is not required.*

MAINTENANCE

The voltage regulator contacts should not be cleaned unless the electrical performance indicates it is necessary. A sooty or discolored condition of the contacts is normal after a relatively short period

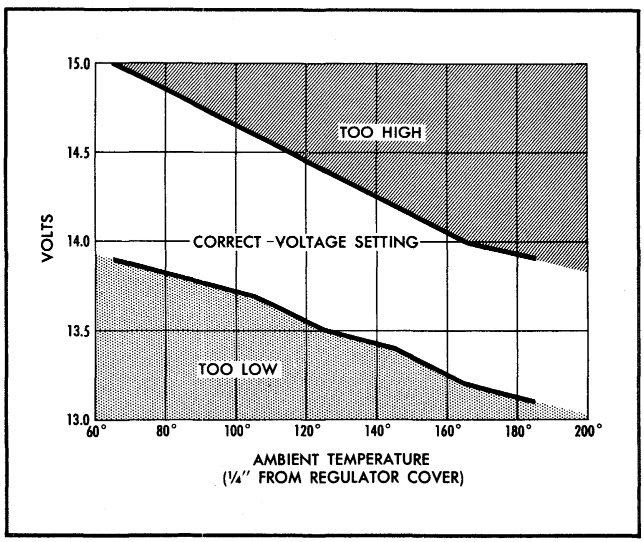



Fig. 11-43 Temperature Correction Chart

of operation and is not an indication that cleaning is necessary. However, if the voltage fluctuates as evidenced by an unsteady voltmeter reading when checking the voltage setting the contacts may have excessive resistance or be sticking and they, therefore, should be cleaned. CAUTION: Before cleaning contacts, make sure the unsteady voltage is not being caused by loose connections or high resistance elsewhere in the system.

The contacts on the voltage regulator unit are of a soft material and must not be cleaned with a file. A strip of No. 400 silicon carbide paper or equivalent folded over and then pulled back and forth between the contacts is recommended as a satisfactory method of cleaning. After cleaning, the contacts should be washed with trichlorethylene or alcohol to remove any residue. If the voltage control has not improved, repeat the cleaning and washing process.

To clean the field relay contacts, use a thin fine-cut, flat file. Remove only enough material to clean the points.

Never use emery cloth or sandpaper to clean contact points.

## TRANSISTOR GENERATOR REGULATOR

### *DESCRIPTION*

The transistor regulator illustrated in Fig. 11-44 is an assembly composed principally of transistors, diodes, resistors, a capacitor, and a thermistor to form a completely static unit containing no moving parts. The transistor is an electrical device which limits the generator voltage to a preset value by controlling the generator field current. The diodes, capacitor and resistors act together to aid the transistor in controlling the voltage, which is the only function that the regulator performs in the charging circuit. The thermistor provides a temperature-compensated voltage setting.

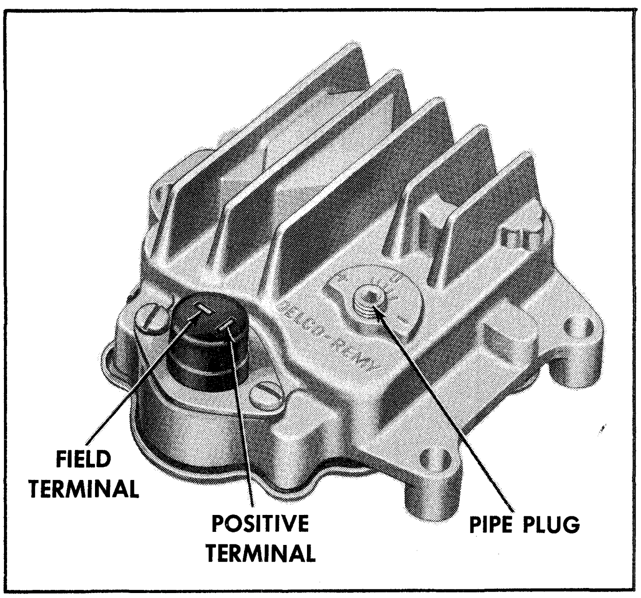



Fig. 11-44 Transistor Regulator

The voltage at which the generator operates is determined by the regulator adjustment. The regulator voltage setting can be adjusted externally by removing a pipe plug in the cover (Fig. 11-44) and turning the adjusting arm inside the regulator. This procedure is explained in a following section, and permits regulator adjustments without removing the cover.

### *OPERATING PRINCIPLES*

A typical wiring diagram showing internal circuits is illustrated in Fig. 11-45. The operating of the

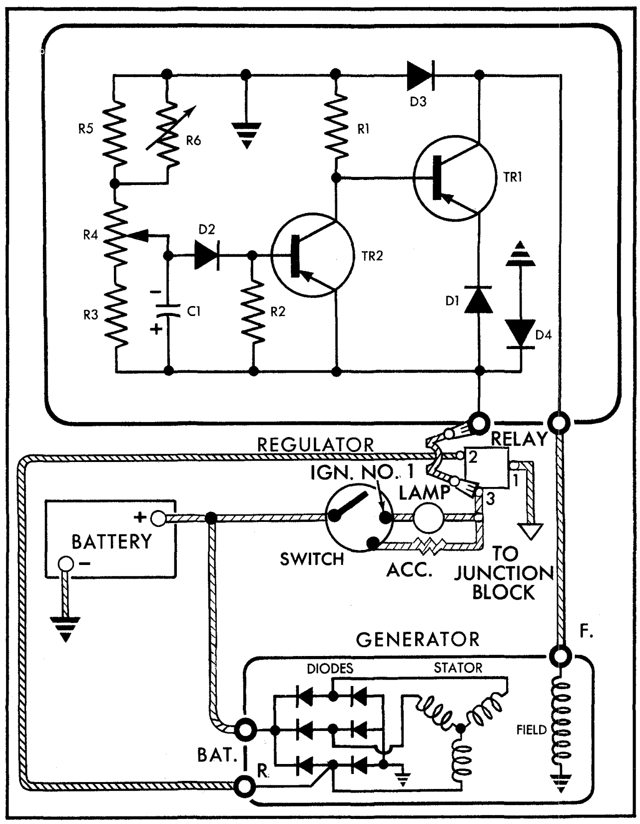



Fig. 11-45 Regulator in Charging Circuit

regulator is described as follows: When the switch is closed current flows through the indicator lamp, resistor, diode DI and transistor TR1 in the regulator to the generator "F" terminal, and then through the generator field winding to ground.

When generator voltage reaches a preset value, the combination relay contacts close to turn the lamp off and connect the field directly to the generator. The other components in the regulator cause transistor "TRI" to alternately "turn-off" and "turn-on" the generator field current. The regulator thus operates automatically to limit the generator voltage to a preset value.

### *REMOVE AND REPLACE REGULATOR*

Refer to Fig. 11-73 which shows installation.

### *TROUBLE DIAGNOSIS*

A wiring diagram is shown in Fig. 11-46.

Most charging system troubles show up as an undercharged or overcharged battery. Since the battery itself may be defective, it should be checked first by the "Light Load Test" to determine its condition. Second, the generator drive belt should be checked for proper tension, and all wiring should be visually inspected for loose or corroded connections.

*NOTE: The battery specific gravity must be 1.215 or above before checks are made as covered below. If battery is below 1.215 recharge before proceeding.*

*CAUTION: Do not short between or ground any of the terminals on the generator. Do not attempt to polarize the generator.*

BATTERY CONDITION

To check for an undercharged battery condition as evidenced by slow cranking, connect a jumper between the No. 1 and No. 3 terminals (Fig. 11-46) on the combination relay, and leave this jumper connected for the following checks. Slide prods into the connector body to make connections. Then follow the procedure beginning with step 1. For an overcharged battery, as evidenced by excessive water usage, begin with step 7; no relay jumper lead is required.

1. Connect an ammeter in the circuit at the generator "BAT" terminal (Fig. 11-47).

2. Connect a voltmeter from "BAT" terminal of generator to ground (Fig. 11-47).

3. Disconnect the wiring harness connector from the generator "F" terminal (Fig. 11-47).

4. Connect a jumper lead from the generator "F" terminal to the generator "BAT" terminal. (A

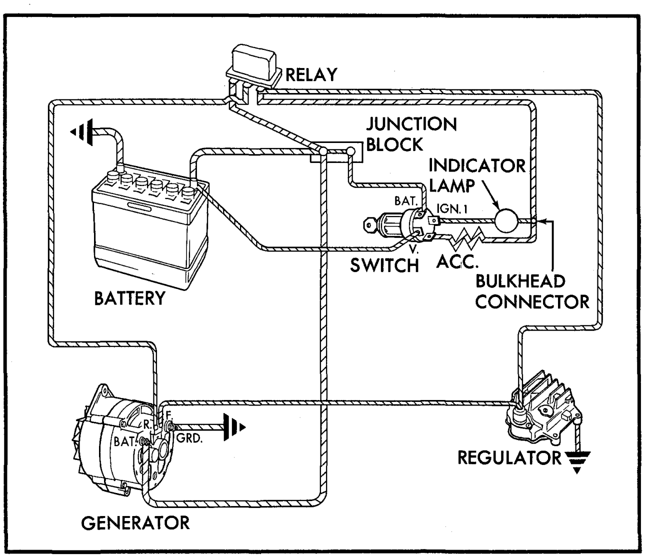



Fig. 11-46 Basic Lead Connections

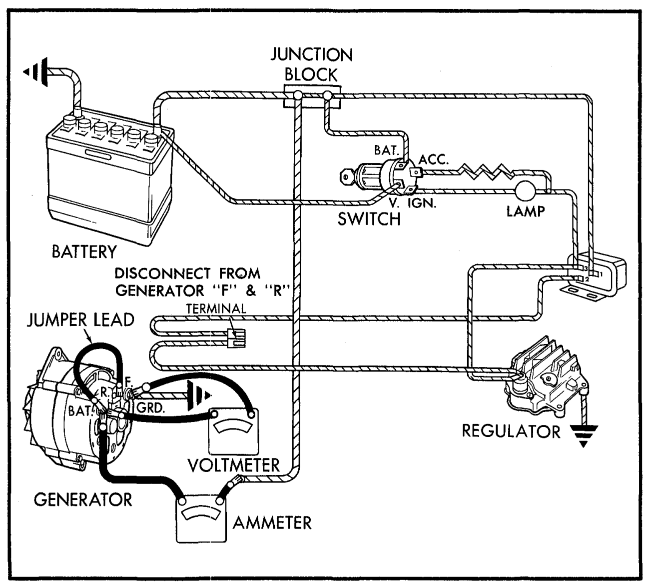



Fig. 11-47 Checking Circuit

special adapter for making this connection is available from the wiring harness manufacturer.) (Fig. 11-47).

5. Operate generator at specified speed, turn on accessories as required to obtain specified voltage, and observe output.

*CAUTION: Avoid high voltage.*

a. If current output is low, remove and check the generator as outlined in the section which describes and discusses the generator.

If a generator failure was caused by a defective stator or diodes, the repaired generator may be installed back on the car and no further checks are needed.

If the generator failure was caused by a defective field winding, the repaired generator may be installed back on the car, and the following checks beginning with step 6 must be made to locate possible damage to the regulator.

b. If the current output meets the specifications proceed as follows:

6. Remove jumper lead and reconnect wiring harness connector to the generator "F" terminal.

7. Insert the special test adapter in the circuit at the regulator terminal. This adapter is available from various automobile type supply outlets. Test connections to the adapter are shown in Fig. 11-48.

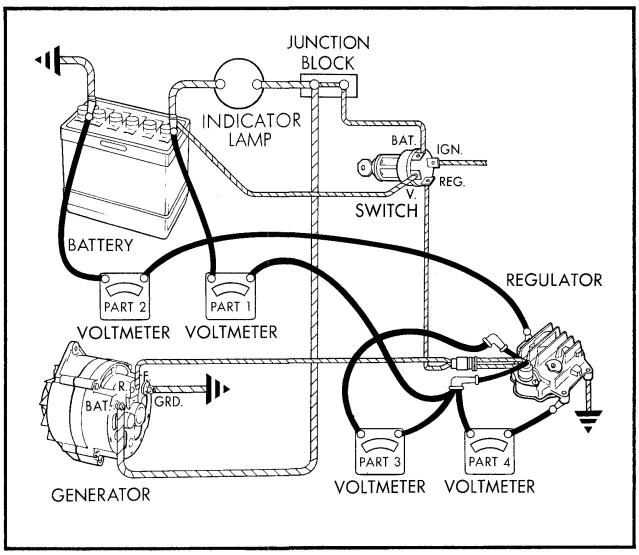



Fig. 11-48 Checking Circuit

8. Turn on ignition switch, but do not start the engine.

9. Connect voltmeter positive lead to battery positive post and voltmeter negative lead to regulator positive terminal. See Part 1, Fig. 11-48. Record the voltage drop.

10. Connect voltmeter positive lead to regulator mounting bolt, and voltmeter negative lead to battery negative post (Fig. 11-49). Record the voltage drop.

11. Add the voltage in Part 9 to the voltage in Part 10.

a. If the total voltage is greater than .25 volt, check ignition switch for poor contacts and system wiring for high resistance.

b. If total voltage is less than .25 volt, proceed as follows:

12. Connect voltmeter positive lead to regulator positive terminal and voltmeter negative lead to regulator "F" terminal. See Part 3, Fig. 11-48. Record the voltage.

a. If the voltage is .9 volt or less, replace the regulator, as the regulator is defective.

b. If the voltage is 2.0 volts or greater, replace the regulator, as the regulator is defective.

c. If the voltage is between .9 and 2.0 volts, proceed as follows:

13. Operate the engine at approximately 1500 r.p.m. for 15 minutes with the lower beam headlights on.

14. With engine running, record voltage reading from the regulator positive terminal to ground. See Part 4, Fig. 11-48.

Compare with Fig. 11-43.

a. If voltage is not within specifications, replace regulator.

b. If voltage reading is within specifications, charging system is satisfactory, but voltage setting needs to be changed to a different value to meet the requirements of driving conditions. Proceed as follows: Remove pipe plug on regulator, and insert

small screwdriver into slot and turn counterclockwise for an undercharged battery one or two notches to increase setting. For an overcharged battery, turn clockwise one or two notches to decrease setting. For each notch moved, the voltage setting will change by .3 volt. Then check for an improved battery condition over a service period of reasonable length.

***REMOVE THE RELAY JUMPER LEAD***

The indicator light now should come on when the switch is on, and should go out when the engine is running. If the light will not come on at all, check for a burned out bulb. If the light will not go out when the engine is running at moderate speed, replace the combination light and field relay.

## IGNITION CIRCUIT

The ignition circuit (Fig. 11-49) includes the distributor, ignition coil, ignition resistance wire, ignition switch, spark plugs, battery, and the resistance type secondary cables.

For battery, see "Starting Circuit."

### PERIODIC SERVICE

The distributor and spark plugs are components of the ignition circuit that require periodic service. The remainder of the ignition circuit requires only periodic inspection to check the operation of the units, tightness of the electrical connections, and the condition of the wiring.

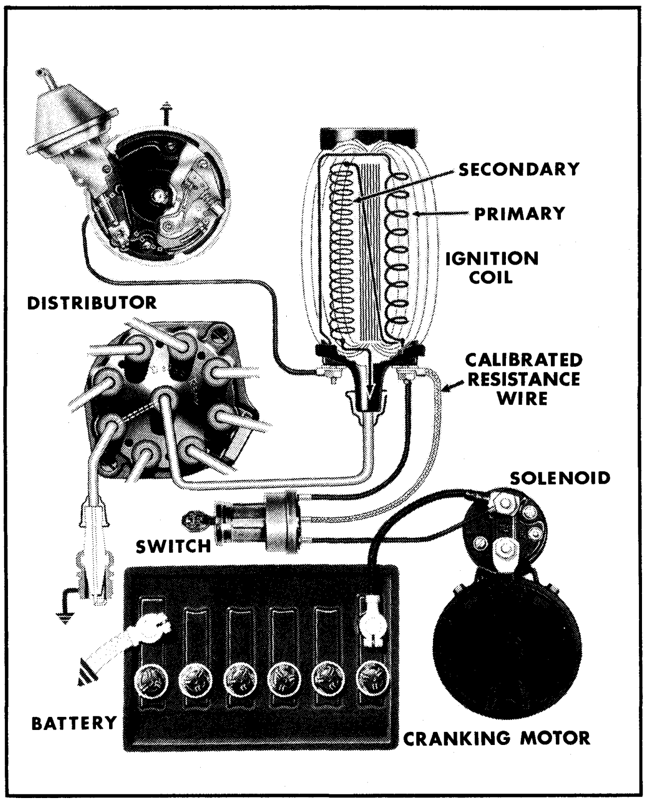



Fig. 11-49 Ignition Circuit

All leads located in either the coil tower or distributor cap should be checked to make sure they are pressed all the way down in their inserts. If rubber boots are used at these connections, they, too, should be tightly in place over the connection.

*CAUTION: Lead from distributor should be connected to coil negative terminal and lead from ignition on switch to coil positive terminal.*

Two types of distributors are used: 1) A 12 volt aluminum, internal adjustment distributor on 6 cylinder Tempests and 2) A 12 volt, cast iron, external adjustment distributor on 8 cylinder Tempests.

Both function in much the same manner to (1) cause a high voltage surge from the coil (2) time these surges with regard to engine requirements through the use of centrifugal and vacuum advance mechanisms (3) direct the high voltage surges through the distributor rotor, cap, and high tension wiring to the spark plugs.

They differ only in appearance and method of adjusting dwell angle.

### DISTRIBUTOR—6 CYLINDER ENGINE

***DESCRIPTION***

The lightweight—high performance type distributor shown in Fig. 11-50 and Fig. 11-51 is constructed with a diecast aluminum housing that provides a unit of light over-all weight. The distributor is designed to operate with the highest efficiency in order that reliable performance may be obtained.

The circuit breaker plate assembly is mounted onto the main housing with two attaching screws. The movable plate is pivoted on the base plate and rides on three nylon bearings. The vacuum control unit

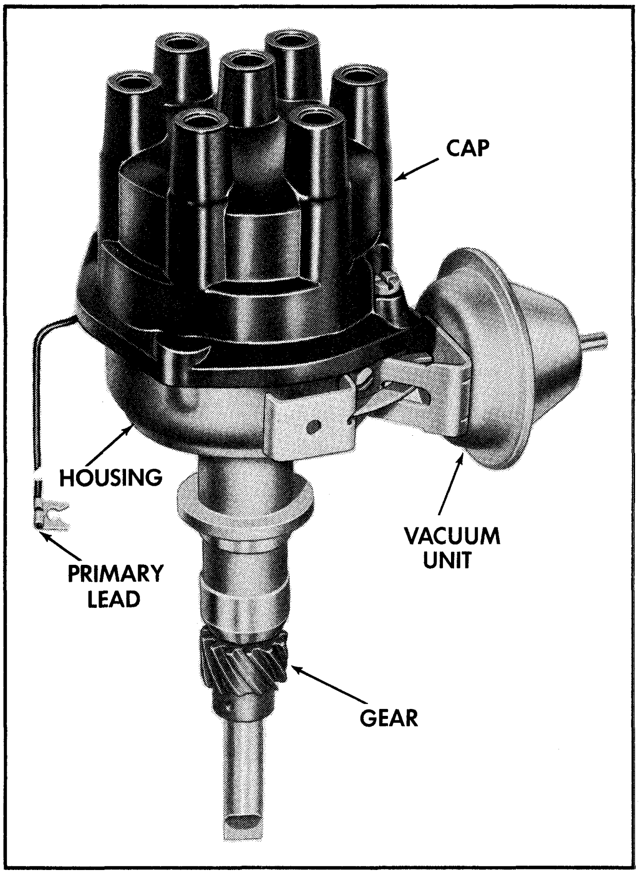



Fig. 11-50 Distributor

is mounted onto the side of the distributor housing. It consists of an enclosed, calibrated, spring loaded diaphragm and is linked mechanically to the moveable plate. The centrifugal advance mechanism is located under the breaker plate assembly, and is a part of the shaft assembly. It consists of an automatic cam actuated by two centrifugal weights controlled by springs.

## MAINTENANCE

### LUBRICATION

No periodic lubrication to the main shaft is required, since the bushings are lubricated by engine crankcase oil. The crankcase oil reaches the upper bushing through channels cut in the housing next to the shaft, and normal splash lubricates the lower bushing. On some models, the upper bushing lubrication is supplemented by oil filled waste located in a cavity next to the bushing. Also, some models do not have a lower bushing, in which case the lower part of the shaft is positioned in a bearing in the engine.

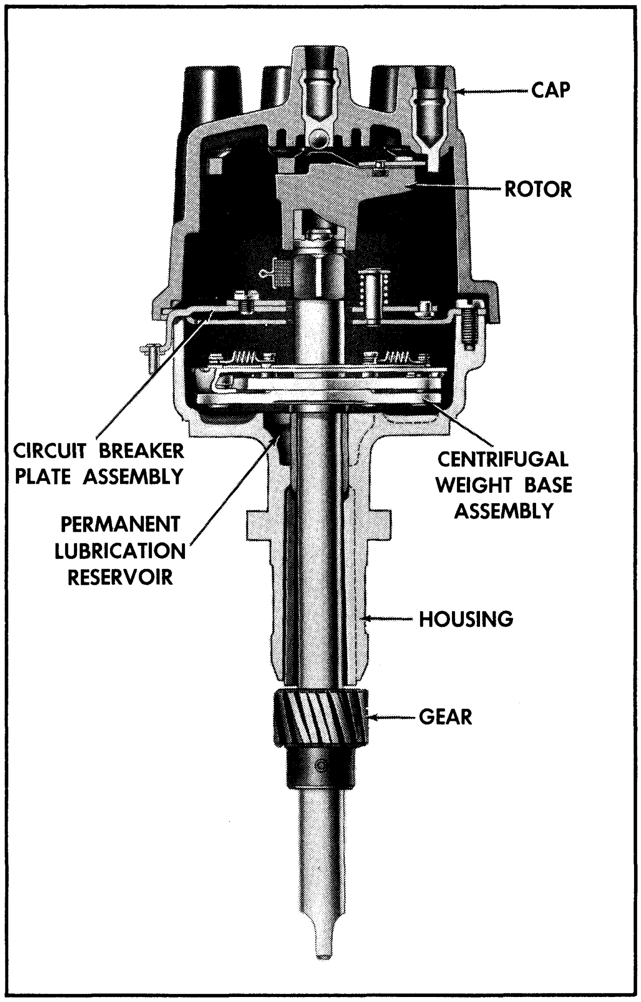



Fig. 11-51 Cross Section of Distributor

When replacing the contact set assembly, a trace of Delco-Remy Cam Lubricant should be placed on the cam. Also, at the same time, lift off the rotor, and place a few drops of SAE #20 oil on the top of the shaft to provide lubrication between the cam and shaft.

### CAP AND ROTOR

The cap and rotor should be checked for chips or cracks and carbonized paths which would allow high tension leakage to ground. The rotor spring should be checked to insure that it has good positive contact against the cap button.

### WIRING

The low and high tension cables should be examined carefully for brittle or cracked insulation

and broken strands. Defective insulation will permit missing or cross firing of the engine. Connections should be clean and tight to reduce resistance. Poor or high resistance connections in the primary wiring can reduce the available voltage for firing the spark plugs. All leads located in either the coil tower or distributor cap should be checked to make sure they are pressed all the way down in their inserts. If rubber boots are used at these connections, they too should be tightly in place over the connections.

TIMING

Periodically the timing of the engine should be checked. If out of adjustment set to 40 BTOC with distributor vacuum hose disconnected. This insures the most efficient engine performance.

CONTACT SET OR BREAKER POINTS

Under most normal operating conditions, distributor contact points will provide many thousands of miles of service. Points which have undergone several thousand miles of operation will have a rough surface or slight transfer of material, but this should not be interpreted as meaning that points are worn out.

Rough contacts which are "greyish" in color have a greater area of contact than new contacts, and will provide satisfactory service until most of the tungsten is worn off.

Pitted or transferred contacts is a normal condition and should not necessarily be replaced unless the transfer has exceeded .020 of an inch (Fig. 11-52).

CONDENSERS

Under most normal operating conditions, the condenser will provide many thousands of miles of

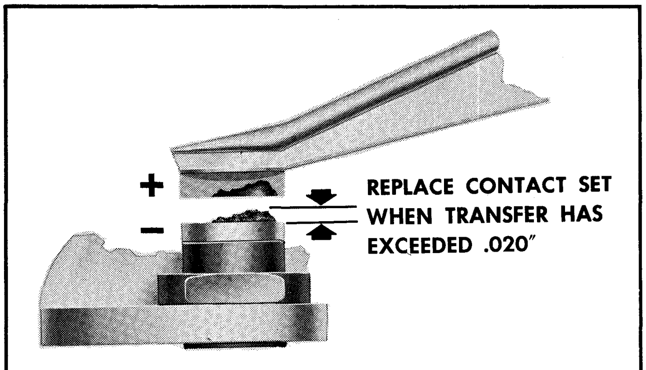



Fig. 11-52 Allowable Contact Material Transfer

service. Before installing a new condenser the existing distributor condenser should be checked to determine if it is still serviceable.

Check the condenser on a reliable make of condenser tester. The condenser should be checked for the following properties:

(1) Insulation Resistance (or Leakage) and Breakdown Test.

(2) Series Resistance.

(3) Capacity (MFD).

## *CHECKS AND ADJUSTMENTS ON VEHICLE*

REPLACING CONTACT SET

The contact set is replaced as a complete assembly. To remove the contact set, merely lift the condenser lead clip and primary lead clip from between the breaker lever spring and insulator, and then remove the contact set attaching screw (Fig. 11-53). The service replacement contact set has the breaker lever spring and the point alignment preadjusted at the factory. Only the dwell angle requires adjusting after replacement.

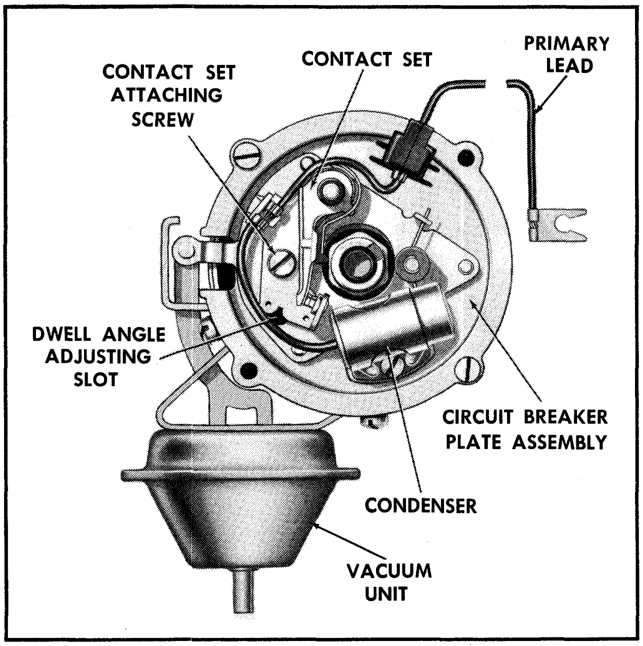



Fig. 11-53 Top View of Distributor
(Cap and Rotor Removed)

ADJUSTING DWELL ANGLE

With the engine running at idle, the dwell angle or cam angle can be measured by a Dwell Angle Meter. IMPORTANT: When checking and adjusting the dwell angle, the vacuum advance unit must be in the full retard, or "no vacuum advance" position since the dwell angle may vary with vacuum advance. To insure that this is the case, disconnect the vacuum line to the distributor during this check. To adjust the dwell angle, loosen the contact set attaching screw, place a screwdriver in the adjusting slot (Fig. 11-53), and turn until 31°-34° dwell angle is obtained.

Tighten the attaching screw, and then recheck the dwell angle reading.

The point opening of the contact points may also be checked with the distributor mounted on the engine. To do this, crank the engine if necessary to locate a lobe on the cam directly under the breaker lever rubbing block. Then use a clean oil-free feeler gauge to measure the point opening. Adjustment procedure is the same as for the dwell angle check.

It is important to remember that adequate point opening and cam angle are both required for good ignition. The maximum cam angle is required only for top engine speeds, but a reasonable point opening is required at all speeds. Therefore, contact points should always separate according to specifications and dwell or cam angle should be within specified limits. Due to difficulty in accurately measuring the point opening of used points, it is recommended that when the dwell or cam angle is measured or set that the point opening should visually be checked to ascertain that it is reasonably close to specifications.

### CHECKS AND ADJUSTMENTS OFF VEHICLE

REMOVE

1. Disconnect distributor-to-coil primary wire.

2. Remove distributor cap.

3. Crank engine so rotor is in position to fire No. 1 cylinder and timing mark on harmonic balancer is indexed with pointer.

4. Remove vacuum line from distributor.

5. Remove distributor clamping screw and hold-down clamp.

6. Remove distributor. It will be noted that the rotor will rotate as the distributor is pulled out of the block. Note the relationship of the rotor and the distributor housing after removal so that the rotor can be set in the same position when the distributor is being installed.

*NOTE: Always set distributor in upright position so oil from distributor shaft will not run out onto breaker plate and points.*

The distributor may be placed in a distributor testing machine or synchroscope to check for variation of spark and centrifugal and vacuum advance.

*IMPORTANT: On models having only one shaft bushing, it is necessary to provide some means of properly positioning the lower part of the shaft during the testing procedures. Many synchroscope manufacturers provide an adapter for this purpose. When checking the dwell angle, the vacuum advance must be in the full retard or "no vacuum advance" position, since the dwell angle may vary with vacuum advance on these types of distributors.*

After testing on a synchroscope, it is recommended that the dwell angle be checked again after the distributor has been mounted on the engine. This will insure that the dwell angle is correct on those models which require special provisions for positioning the lower part of the shaft on the synchroscope.

The procedure for replacing the contact set and adjusting the dwell angle and point opening is covered in the previous section entitled "Checks and Adjustments of Distributor on the Vehicle."

### DISASSEMBLY AND REASSEMBLY

DISASSEMBLE

1. Loosen screws retaining distributor cap and remove cap and rotor.

2. Disconnect primary and condenser leads from between plastic retainer and breaker set spring. Remove breaker points adjusting and hold down screw and remove breaker points assembly.

3. Remove primary lead and retainer.

4. Remove condenser and bracket.

5. Remove screws from vacuum advance diaphragm bracket. With slight downward pressure to disengage lever, remove vacuum advance assembly.

6. Remove screws securing breaker plate and remove breaker plate.

7. Remove roll pin from driven gear and remove driven gear and washer.

8. Pull centrifugal advance assembly out of distributor housing and remove screws and washers securing centrifugal advance upper plate.

9. Remove weight control springs, weights from base plate and pull breaker cam assembly from main shaft.

ASSEMBLE

Assembly of the distributor is the reverse of the disassembly procedure outlined above. When installing the gear on the shaft, use a new roll pin. The pin must be tight in the hole to prevent any movement between the gear and the shaft.

INSTALL

1. Check to see that engine is at firing position for No. 1 cylinder (No. 1 piston at top of compression stroke) and timing mark on harmonic balancer is indexed with pointer.

2. Position new distributor to block gasket on block.

3. Before installing distributor, index rotor with housing as noted when distributor was removed. This will simplify indexing the distributor shaft and gear with the oil pump drive shaft and the drive gear on the camshaft. Distributor and rotor will be positioned properly when installed with No. 1 piston in firing position.

4. Replace distributor clamp leaving screw loose enough to allow distributor to be turned for timing adjustment.

5. Install spark plug wires in distributor cap. Place wire for No. 1 cylinder in tower (marked on old cap during disassembly), then install remaining wires around the cap according to the firing order (1-5-3-6-2-4).

6. Attach distributor to coil primary wire.

7. Replace distributor cap.

8. Adjust timing and then tighten distributor clamp screw.

9. Attach vacuum line to distributor.

## DISTRIBUTOR—8 CYLINDER ENGINE

### *DESCRIPTION*

The external adjustment type distributor is shown in Fig. 11-54. The cap has a window for adjusting dwell angle with the cap in place. Adjustment of dwell can be made on the car while the engine is operating or while the distributor is being operated on a distributor tester. The centrifugal advance components are located above the breaker plate and cam. This arrangement allows the cam and the breaker lever to be located directly adjacent to the upper bearing for increased stability. The breaker plate is of one piece construction and rotates on the outer diameter of the upper bearing. The plate is held in position by a retainer clip in the upper shaft bushing. The molded rotor serves as a cover for the centrifugal advance mechanism. The vacuum control unit is mounted under the movable breaker plate to

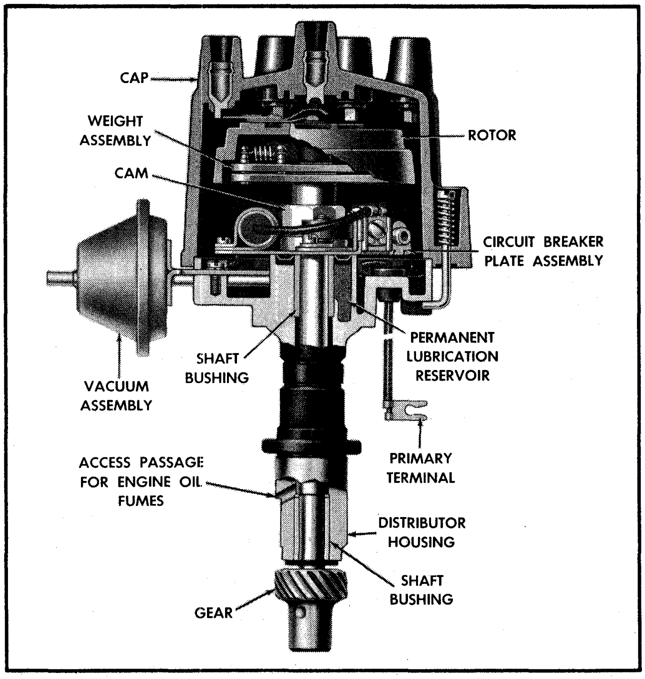



Fig. 11-54 V-8 Engine Distributor

the distributor housing. The contact set is attached to the movable breaker plate. The service replacement contact set has the breaker lever spring tension and point alignment preadjusted at the factory and is serviced as one complete assembly. Only the point opening (dwell angle) requires adjustment after replacement.

The vacuum advance on automatic transmission cars is connected directly to manifold vacuum so there is full vacuum advance at idle. During acceleration or when the engine is pulling heavy, the vacuum is not sufficient to actuate the diaphragm. The movable plate is held in the retarded position by a calibrated return spring which bears against the vacuum disphragm.

Cars equipped with synchro-mesh transmissions do not have distributor vacuum at idle but operate similarly above idle speed.

The centrifugal advance mechanism consists of a centrifugal advance cam actuated by two centrifugal weights controlled by springs. As the speed of the distributor shaft increases with engine speed, the weights are thrown outward against the pull of the springs. This advances the breaker arm causing the contact points to open earlier and thus advancing the spark.

***PERIODIC SERVICE***

A permanent lubricant reservoir is built into the distributor housing to lubricate the upper end of the shaft. No periodic lubrication is required.

When replacing the contact set assembly apply a trace of petrolatum to the breaker cam. No other lubrication is required. The movable breaker plate is lubricated by lubricant from the upper shaft bushing.

This distributor also requires periodic inspection of cap and rotor, wiring, and point condition, and a check for correct spark timing. This should be done at each tune-up and at least every spring and fall.

ADJUSTMENT

1. With the engine operating, raise the window provided in the cap.

2. Insert a "Hex" type wrench into the head of the adjusting screw as shown in Fig. 11-55.

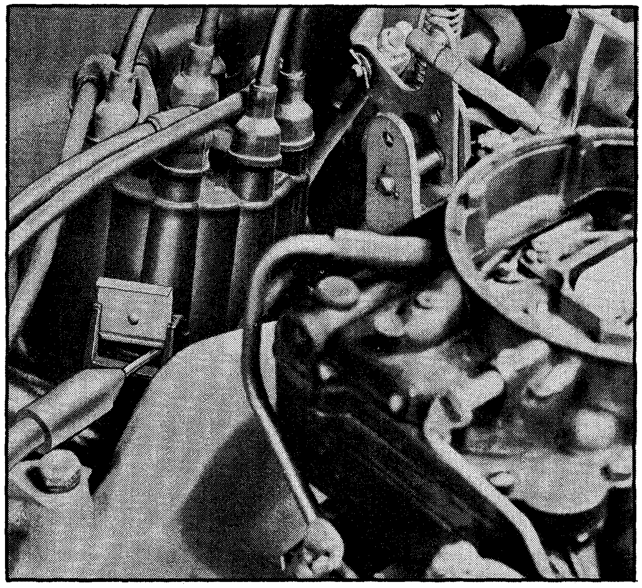


Fig. 11-55 Adjusting Dwell Angle

3. Turn screw to adjust point opening by one of the following methods:

PREFERRED METHOD

Turn the adjusting screw until the 28°-32° dwell is obtained as measured by a dwell meter. (When using dwell meter be sure to test distributor resistance before testing dwell angle.)

*NOTE: Providing the dwell meter is accurate and is used correctly, points can be set very accurately. Several design features such as the use of the upper shaft bushing as a bearing for the breaker plate, and the construction of the advance mechanism have made this possible.*

ALTERNATE METHOD

Turn the adjusting screw (clockwise) until the engine begins to misfire. Then turn the screw one-half turn in the opposite direction (counterclockwise). This will give the proper dwell angle.

REMOVE

1. Disconnect distributor-to-coil primary wire.

2. Remove distributor cap.

3. Crank engine so rotor is in position to fire No. 1 cylinder and timing mark on harmonic balancer is indexed with pointer.

4. Remove vacuum line from distributor.

5. Remove distributor clamping screw and hold-down clamp.

6. Remove distributor and distributor to block gasket. It will be noted that the rotor will rotate as the distributor is pulled out of the block. Note the relationship of the rotor and the distributor housing after removal, so that the rotor can be set in the same position when the distributor is being installed.

*NOTE: Always set distributor in upright position so oil from distributor shaft will not run out onto breaker plate and points.*

INSPECT

With the distributor removed from the vehicle it is advisable to place the distributor in a distributor testing machine or synchroscope. When mounting distributor in tester, first secure the gear in the drive mechanism, then push distributor housing down toward the gear to take up end play between the gear and housing, and finally secure the housing in the tester. Test the distributor for variation of spark, correct centrifugal and vacuum advance, and condition of contacts. This test will give valuable information on the distributor condition and indicate parts replacement which may be necessary.

When checking the distributor condenser it should be checked with a reliable condenser tester. The condenser should be checked for the following properties: (1) insulation resistance (or leakage), (2) series resistance, (3) breakdown test, (4) capacity (mfd.).

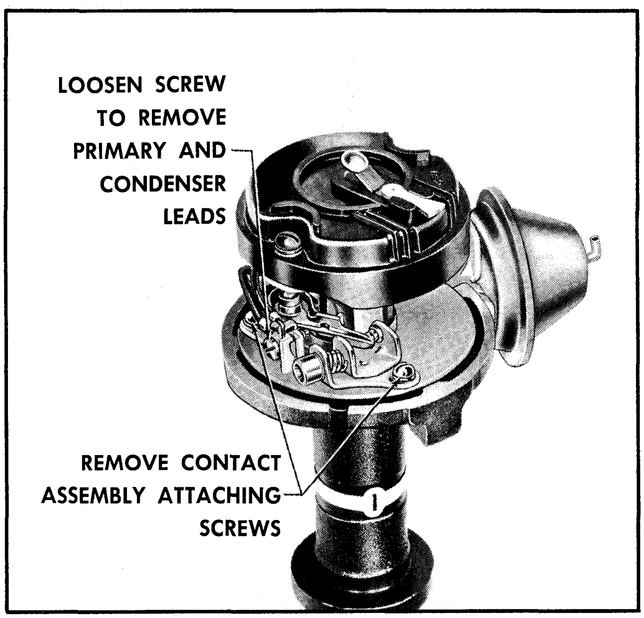



Fig. 11-56 Distributor Contact Details

***REPLACE CONTACT SET***

The contact point set is replaced as one complete assembly. The breaker lever spring tension and point alignment of the service contact set have been preadjusted at the factory. Only the point opening requires adjusting after replacement.

Replace contact set

Replace contact set as follows:

1. Remove two attaching screws (Fig. 11-56) which hold base of contact set assembly in place.

2. Remove condenser lead and primary lead from nylon insulated connection by turning screw (Fig. 11-56) in contact set.

3. Replacement is the reverse of removal.

*CAUTION: Make sure the condenser lead and primary lead are located as in Fig. 11-57. Leads must be properly located to eliminate interference between leads and cap, weight base, or breaker plate.*

4. Apply a trace of petrolatum to the breaker cam.

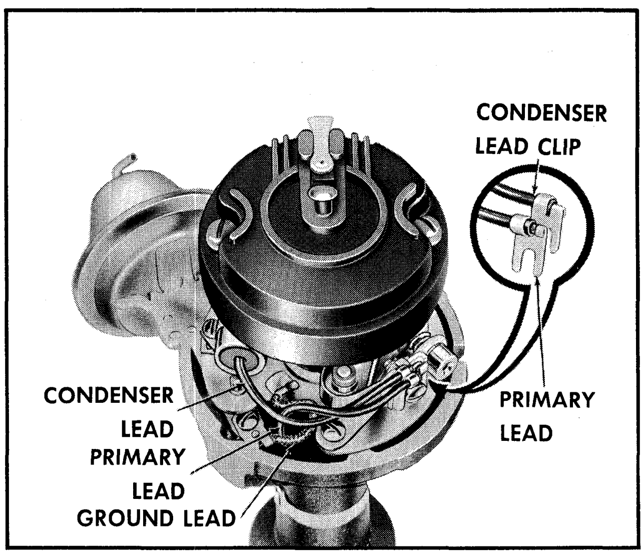



Fig. 11-57 Arrangement of Leads

### ADJUST DWELL ANGLE

The following method can be used to adjust the dwell angle to the proper setting with the distributor removed from the car.

*NOTE: Dwell should always be rechecked after the distributor is installed in the car.*

1. With distributor mounted in distributor testing machine, connect the dwell meter to the distributor primary lead.

2. With the distributor operating, turn the adjusting screw (Fig. 11-55) until the proper dwell angle is obtained.

### DISASSEMBLE

1. Remove the rotor by removing the two attaching screw, lockwashers, and flatwashers (Fig. 11-58).

*NOTE: It will be observed that the rotor is doweled to the weight base so that it can be installed in only one position.*

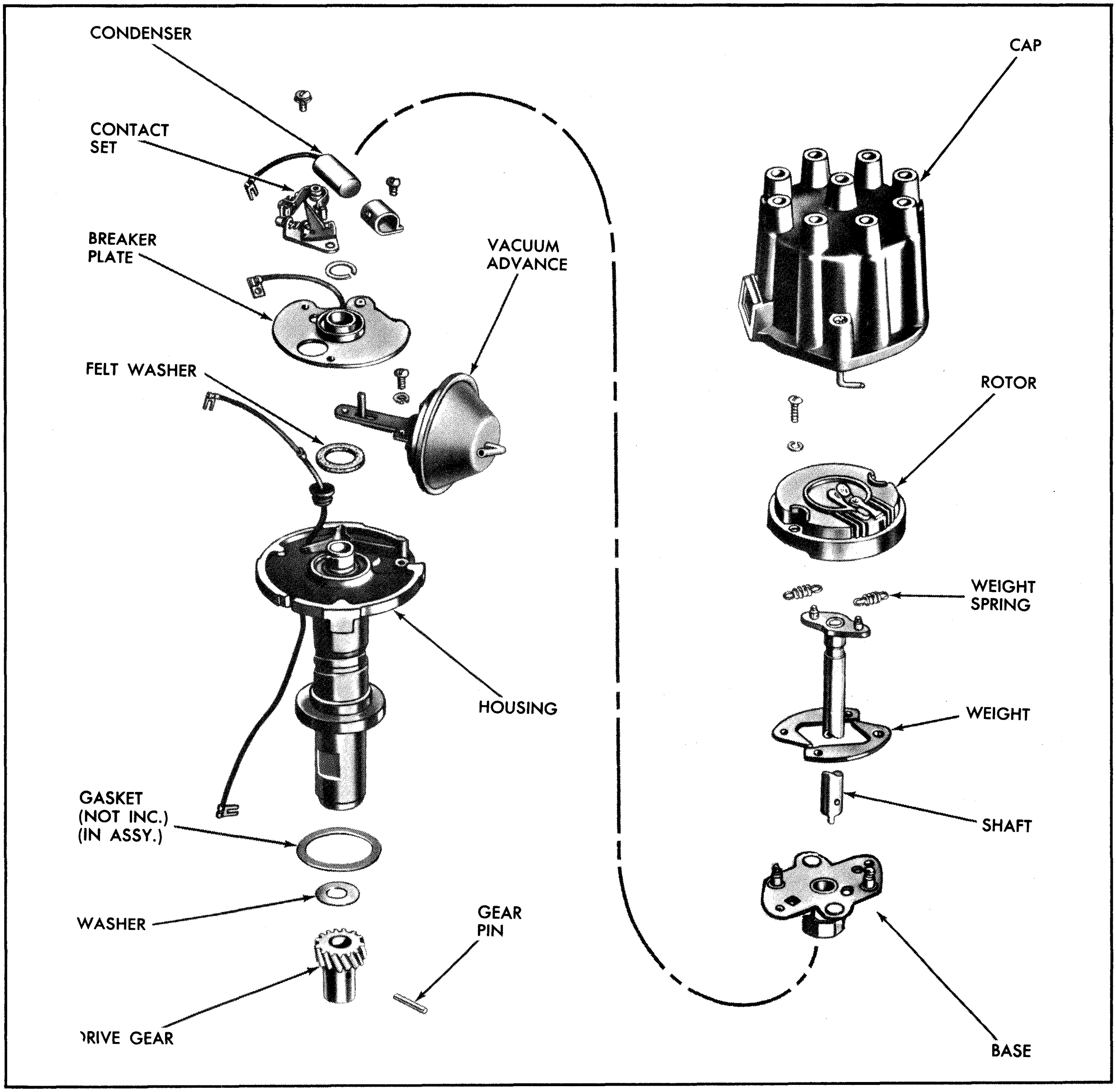



Fig. 11-58 V-8 Engine Distributor - Exploded View

2. Remove both the weight springs and both the advance weights.

3. Remove retaining pin from the gear by driving it out of the gear with a drift and hammer.

*CAUTION: Distributor should be supported in such a way that the distributor shaft will not be damaged when driving the pin out.*

4. Slide gear and washer off the shaft.

5. Pull shaft and cam-weight base assembly from the housing.

6. Remove contact set assembly.

7. Remove condenser hold-down screw, condenser and bracket from the breaker plate.

8. Remove spring retainer and raise plate from the housing.

9. Remove two attaching screws and lockwashers and plate ground lead, and remove the vacuum advance unit.

10. Remove felt washer from around bushing in the housing.

*NOTE: No attempt should be made to service the shaft bushings in the housing, as the housing and bushings are serviced as a complete assembly.*

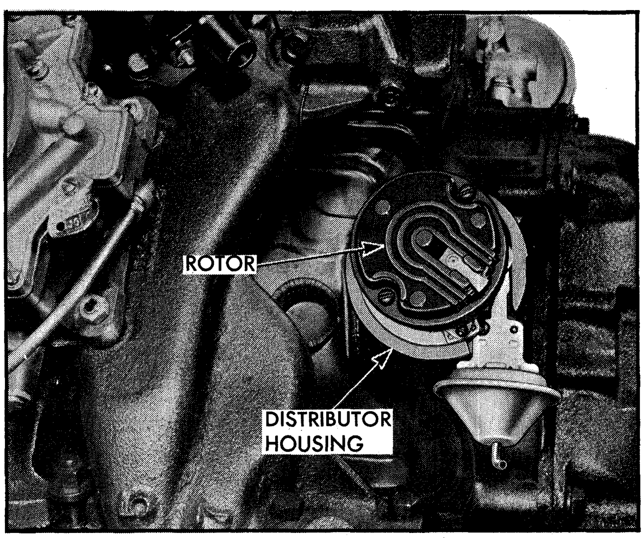



Fig. 11-59 Relationship of Distributor Housing in Firing Position for No. 1 Cylinder

### ASSEMBLE

Assembly of the distributor is the reverse of the disassembly procedure outlined above. When installing the gear on the shaft use a new retaining pin. The pin must be tight in the hole to prevent any movement between the gear and the shaft.

Note that the rotor can be installed in only one position. It will be broken if an attempt is made to install it backwards.

### INSTALL

1. Check to see that engine is at firing position for No. 1 cylinder (No. 1 piston at top of compression stroke) and timing mark on harmonic balancer is indexed with pointer (Fig. 11-62).

2. Position new distributor to block gasket on block.

3. Install distributor in block so that vacuum diaphragm faces the left side of the engine and rotor points toward contact in cap for No. 1 cylinder. Before installing distributor, index rotor with housing as noted when distributor was removed. This will simplify indexing the distributor shaft and gear with the oil pump drive shaft and the drive gear on the camshaft. Distributor and rotor will be positioned as shown in Fig. 11-59 when properly installed with No. 1 piston in firing position.

4. Replace distributor clamp leaving screw loose enough to allow distributor to be turned for timing adjustment.

5. Install spark plug wires in distributor cap. Place wire for No. 1 cylinder in tower (marked on old cap during disassembly), then install remaining wires counterclockwise around the cap according to the firing order (1-8-4-3-6-5-7-2).

6. Attach distributor to coil primary wire.

7. Replace distributor cap.

8. Adjust dwell and timing and then tighten distributor clamp screw.

9. Attach vacuum line to distributor.

## SPARK PLUGS

### DESCRIPTION

AC type 46N spark plugs are used with 6 cylinder engines and 45S spark plugs are used with V-8 engines to provide optimum performance for all normal service.

Normal or average service is assumed to be a mixture of idling, slow speed, and high speed operation with some of each making up the daily total driving. Occasional or intermittent high speed driving is essential to good spark plug performance as it provides increased and sustained combustion heat that burns away any excess deposits of carbon or oxide that may have accumulated from frequent idling or continual stop-and-go or slow-speed driving.

Spark plugs in Pontiac Tempest engines are protected by an insulating nipple made of special heat resistant material which covers the spark plug terminal and extends downward over a portion of the plug insulator. These nipples prevent "flash-over", with resultant missing of the engine, even though a film is allowed to accumulate on the exposed portion of the plug porcelains. NOTE: Do not mistake "Corona" discharge for "flash-over" or a shorted insulated. Corona is a steady blue light appearing around the insulator, just above the shell crimp. It is the visible evidence of a high tension field, and has no effect on ignition performance. Usually it can be detected only in darkness. This discharge may repel dust particles, leaving a clear ring on the insulator just above the shell. This ring is sometimes mistakenly regarded as evidence that combustion gases have blown out between shell and insulator.

All AC Spark Plugs have a type number on the insulator which designates the thread size as well as relative position of the plug in the "Heat Range". Type numbers starting with "4" are 14 mm. thread size.

The last digit of the type number indicates the "Heat Range" position of the plug in the AC Heat Range System. Read these numbers as you would a thermometer—the higher the last digit, the "hotter" the plug will operate in the engine; the lower the last digit, the "cooler" the plug.

### PERIODIC SERVICE

Periodically (the actual time depending on operating conditions) the plugs should be removed for cleaning, inspection and regapping.

REMOVE

1. Remove spark plug wires.

2. Remove any foreign matter from around spark plugs by blowing out with compressed air.

3. Using a 13/16" spark plug socket, remove the spark plugs.

INSPECT

Spark plug life is governed to a large extent by operating conditions and plug life varies accordingly. To insure peak performance, spark plugs should be checked, cleaned and regapped every 5000 miles.

Worn and dirty plugs may give satisfactory operation at idling speed, but under operating conditions they frequently fail. Faulty plugs are evident in a number of ways such as wasting gas, power loss, loss of speed, hard starting and general poor engine performance.

Spark plug failure, in addition to normal wear may be due to dirty or leaded plugs, excessive gap or broken insulator.

Dirty or leaded plugs may be evident by black carbon deposits, or red, brown, yellow or blistered oxide deposits on the plugs. The black deposits are usually the result of slow speed driving and short runs where sufficient engine operating temperature is seldom reached. Worn pistons, rings, faulty ignition, over-rich carburetion and spark plugs which are too "cold" will also result in carbon deposits. Red, brown, etc., oxide deposits, a consequence of the use of leaded fuel; usually result in spark plug failure under severe operating conditions. The oxides have no adverse effect on plug operation as long as they remain in a powdery state. But, under high speed or hard pull, the powder oxide deposits melt and form a heavy glaze coating on the insulating which, when hot, acts as a good electrical conductor, allowing current to follow the deposits and short out the plug.

Excessive gap wear on plugs of low mileage, usually indicates the engine is operating at high speeds or loads that are consistently greater than normal or that a plug which is too "hot" is being used. In addition, electrode wear may be the result of plug overheating, caused by combustion gases leaking past the threads and gasket, due to insufficient compression of the spark plug gasket, dirt

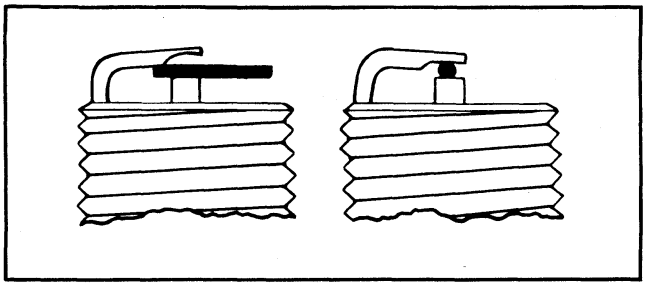


Fig. 11-60 Flat Feeler Versus Round Wire Gauge for Measuring Spark Plug Gap

under the gasket seat, or the use of old gaskets. Too "lean" carburetion will also result in excessive electrode wear.

Broken insulators are usually the result of improper installation or carelessness when regapping the plug. Broken upper insulators usually result from a poor fitting wrench or an outside blow. The cracked insulator may not make itself evident immediately, but will as soon as oil or moisture penetrates the fracture. The fracture is usually just below the crimped part of the shell and may not be visible.

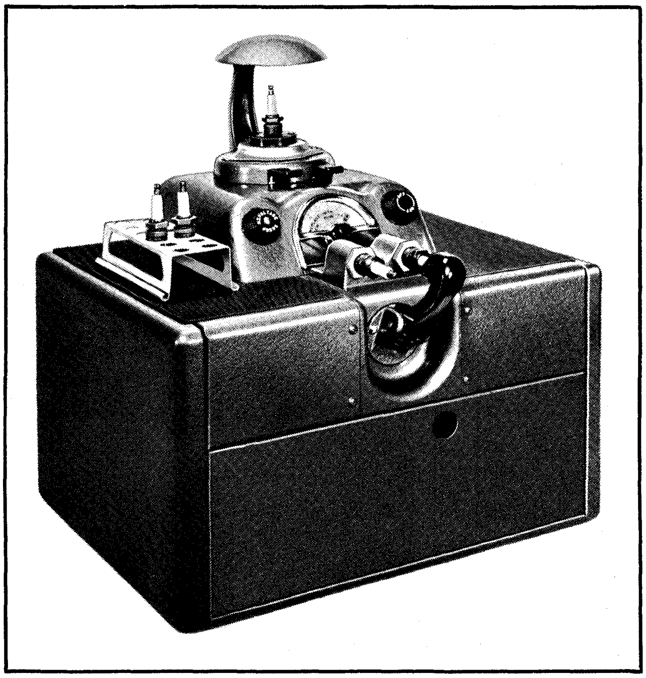


Fig. 11-61 Spark Plug Cleaner and Indicator

Broken lower insulators usually result from carelessness when regapping and generally are visible. In fairly rare instances, this type of a break may result from the plug operating too "hot" such as encountered in sustained periods of high speed operation or under extremely heavy loads. When regapping a spark plug, to avoid lower insulator breakage, always make the gap adjustment by bending the ground (side) electrode. Never bend the center wire. Spark plugs with broken insulators should always be replaced.

***CLEAN AND REGAP***

Clean the spark plugs thoroughly using an abrasive type cleaner. All spark plugs must be of the same make and number or heat range. Use a round feeler gauge to adjust the spark plug gaps to .035" (Fig. 11-60). Test spark plugs following instructions furnished with Spark Plug Cleaner and Indicator (Fig. 11-61).

*CAUTION: Before adjusting gap, file center electrode flat. In adjusting the spark plug gap, never bend the center electrode which extends through the porcelain center. Always make adjustments by bending the ground (side) electrode.*

INSTALL

1. Inspect spark plug hole threads and clean before installing plugs. Corrosion deposits can be removed with a 14 mm. x 1.25 SAE spark plug tap (available through local jobbers) or by using a small, soft wire brush in an electric drill. If a tap is used, coat it with plenty of grease to catch any chips.

*CAUTION: Use extreme care when using tap to prevent cross threading. Also, crank engine several times to blow out any material dislodged during cleaning operation.*

2. Install spark plugs in engine, using new gaskets, and tighten to 20-25 lb. ft. torque.

### *SPARK PLUG TROUBLE DIAGNOSIS*

| PLUG CONDITIONS | FACTORS CAUSING THIS CONDITION | CORRECTIVE ACTION |
|---|---|---|
| Plug "Flash Over" (Firing from upper terminal to base of plug). | Dirty insulator tops—oil, dirt and moisture on insulator will shunt current to base of plug. The above condition can be caused by failure of spark plug boot. | Keep plugs wiped clean with cloth moistened with cleaning solvent. Check spark plug boot and replace if necessary. |
| Oil or Carbon Fouling. | Wet, black deposits on firing end of plug indicate oil pumping condition. This is usually caused by worn piston rings, pistons, cylinders or sticky valves. | Correct engine condition. In most cases plugs in this condition will be serviceable after proper cleaning and regapping. |
| | Soft, fluffy, dry carbon deposits usually indicate a rich mixture operation, excessive idling, improper operation of automatic choke or faulty adjustment of carburetor. | If troubles are not eliminated, use "hotter" type plug. |
| | Hard baked-on, black carbon deposits result from use of too cold a plug. | Use "hotter" type plug. |
| Lead Fouling (Light and powdery or shiny glazed coating on firing end). | By-products of combustion and fuel additives, deposited as a powder which may later melt and glaze on insulator tip. | Remove deposits by blast cleaning. If this is not possible, plugs should be replaced. |
| Normal Electrode Wear. | Due to instense heat, pressure and corrosive gases together with spark discharge, the electrode wears and gap widens. | Plugs should be regapped every 5000 miles. |
| Rapid Electrode Wear. | Condition may be caused by (1) burned valves, (2) gas leakage past threads and seat gaskets, due to insufficient installation torque or damaged gasket (3) too lean a mixture or (4) plug too "hot" for operating speeds and loads. | Correct engine condition. Install plugs to specified torque. Use a new spark plug seat gasket each time a new or cleaned spark plug is installed. Use "colder" type plug if condition continues to exist. |
| Broken Upper Insulator (Firing around shell crimp under load conditions). | Careless removal or installation of spark plug. | Replace with a new spark plug. |
| Broken Upper Insulator (Firing Tip). | The cause is usually carelessness in regapping by either bending of center wire to adjust the gap, or permitting the gapping tool to exert pressure against the tip of the center electrode or insulator, when bending the side electrode to adjust the gap. | Replace with a new spark plug. |

| PLUG CONDITION | FACTORS CAUSING THIS CONDITION | CORRECTIVE ACTION |
|---|---|---|
| Broken Upper Insulator (Firing Tip). (Cont'd.) | Fracture of breakage of lower insulator may also occasionally occur if the engine has been operated under conditions causing severe and prolonged detonation or pre-ignition. | Use "colder" type plug for the particular type of operation. |
| Damaged Shell. | Very seldom occurs but cause is almost always due to mishandling by applying excessive torque during installation. This failure is usually in the form of a crack in the Vee of the thread next to the seat gasket or at the groove below the hex. | Replace with a new spark plug. |

## IGNITION COIL AND RESISTOR

The 12 volt coil is an oil filled, hermetically sealed unit designed specifically for use with an external resistance. The number of turns in the primary winding results in a higher inductance in this winding, which makes it possible for this coil to provide a higher secondary voltage output throughout the speed range.

In order to improve ignition performance during cranking an external resistance is used. This resistor is an integral part of the wiring and is calibrated to the proper value.

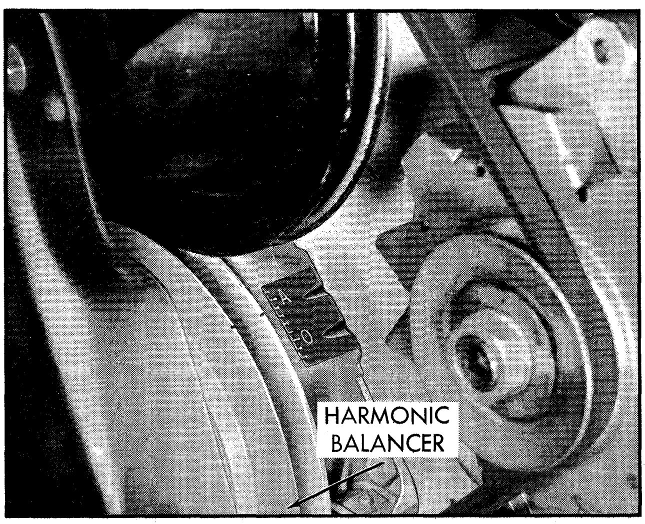



Fig. 11-62 Timing Marks - 6 Cylinder Engine

For optimum starting performance at low temperatures, the resistance is by-passed during cranking, thereby connecting the ignition coil directly to the battery. This provides full battery voltage available at the coil and thus keeps ignition voltage as high as possible during cranking. The resistance is by-passed automatically through the ignition and starting switch when the switch is in the "start" position.

## SECONDARY IGNITION CABLES

All ignition cables in the secondary or high tension system (coil to distributor and distributor to plugs) are neoprene jacketed: This cable is resistant to the action of oil, grease, battery acid and road salt, and offers resistance to corona breakdown. Ignition cables have a multiple, cloth thread core impregnated with a graphite solution to give the correct conductivity. These cables give proper resistance for suppression of radio and television interference.

No external suppressors should be used on the ignition system on car radio installation.

## IGNITION TIMING

Correct timing of the spark, with relation to engine piston position, is made in the shop by use of a power timing light and timing marks on the harmonic balancer (Figs. 11-62, 11-63).

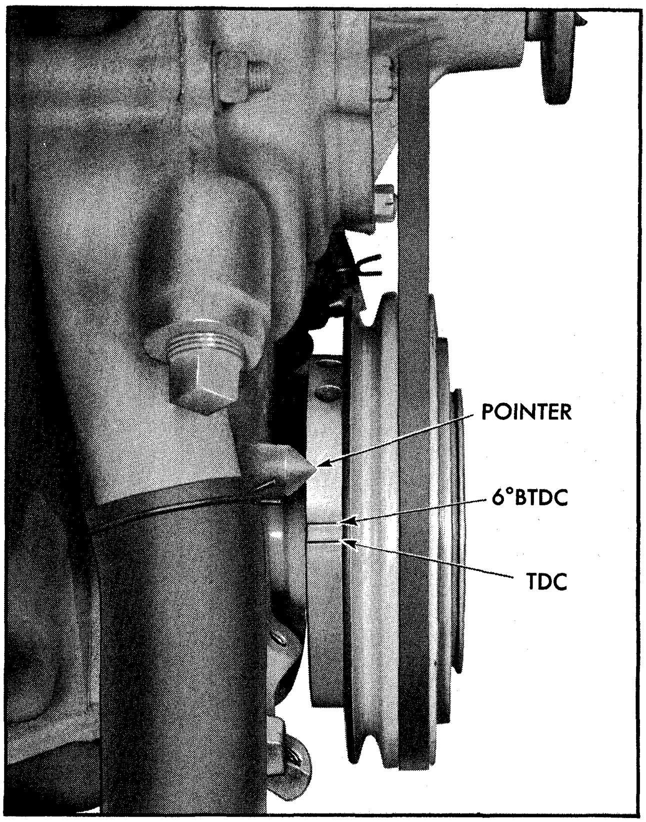



Fig. 11-63 Timing Marks - V-8 Engine

It is imperative, due to vacuum advance at idle, to disconnect the distributor vacuum advance line before setting ignition timing.

At the time the spark is adjusted, the general appearance of the breaker points should be observed. If a smudge line appears on the point support and breaker plate just beneath the points, burned points (from oil or crankcase vapor between the points) are very probable. Points which have gone several thousand miles will have a rough surface, but this does not mean the points are worn out. The roughness between points matches so that a large contact area is maintained and the points will continue to provide satisfactory service. If dirt or scale are present the points should be cleaned with a few strokes of a clean, fine-cut, contact file. Do not attempt to remove all roughness or dress the point surfaces down smooth. Never use emery cloth or sandpaper to clean points. If points are burned or badly pitted they should be replaced and the cause of this condition found and corrected. If this is not done the new points will also burn and pit in a short time.

Adjust ignition timing as follows:

1. Adjust breaker point gap.

2. Connect power timing light.

3. Loosen distributor clamp screw and rotate distributor until power timing light shows that pointer is at 4° BTDC on timing pad 6 cyl., 6° BTDC on harmonic balancer V-8. Tighten distributor clamp screw to 15-20 lb. ft. torque.

## IGNITION AND STARTING SWITCH

The ignition and starting switch is key-operated to close the ignition primary circuit and to energize the starting motor solenoid for cranking.

The ignition switch has four positions, "Off" when the key is straight up and down, "Accessory" when turned to the left, "On" when turned to the right until spring pressure is felt, and "Start" when turned fully to the right against spring pressure.

With the switch in either the "Accessory" or "On" positions the following electrical circuits are activated: stop lights, air conditioning, directional signals, parking brake warning light, radio, back-up lights, heater and defroster and electric windshield wiper. In the "On" position the ignition primary circuit is activated through the resistance and the alternator field current.

There are eight terminals on the back of the switch. The terminal marked "Bat" is connected to the battery and supplies the power to the switch. The accessory terminal supplies power to the accessories when the switch is in the "Acc" or running positions. The "Sol" terminal supplies power to the solenoid to activate the starter in the start position. The terminal marked "Ground" completes the test circuit for the temperature "Hot" indicator bulb when the switch is turned to the start position.

These circuits are all cut off when the ignition switch is in the "Off" or "Start" positions.

When the ignition switch is turned to the start position, the ignition primary circuit is activated directly, by-passing the resistance, and the starting motor circuit is activated to crank the engine.

Two ignition terminals, marked "Ign-1" and "Ign-2", will be found on the back of the switch. The "Ign-1" terminal is energized when the ignition switch is in the normal operating position. It directs current to the ignition coil through the resistance. The "Ign-2" position is energized when the ignition switch is turned to the starting position. It directs

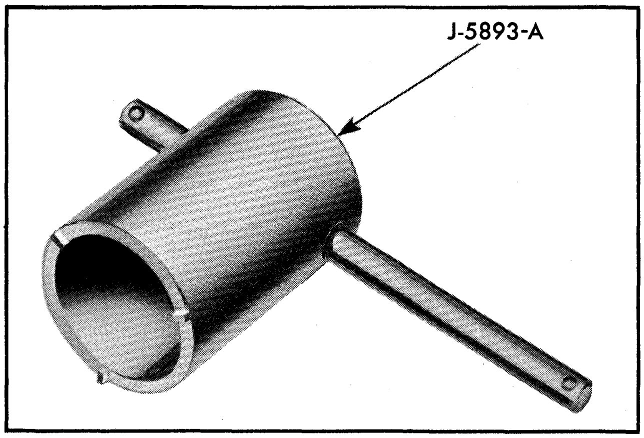



Fig. 11-64 Ignition Switch Ferrule Spanner

current to the coil around the resistance to provide full battery voltage to the coil when starting.

The two terminals "V" and "Reg" are connected to a special set of contacts inside the ignition switch. Externally the "V" terminal is connected directly to the battery and the "Reg" terminal is connected to the No. 3 terminal of the voltage regulator. When the ignition switch is in the "on" position the special set of contacts are closed and current flow can be traced from the battery, through the switch, through the voltage regulator to the field terminal of the alternator, and finally through the rotor field coil windings to ground.

### *REPLACE SWITCH*

1. Remove positive cable from battery to protect against short circuit.

2. Remove ignition switch ferrule by unscrewing with special spanner J-5893-A (Fig. 11-64).

3. Remove switch from back of instrument panel and disconnect wires.

4. Replace switch by reversing above steps.

### REPLACE SWITCH LOCK CYLINDER

1. Place ignition key in lock and depress lock plunger by inserting small pin through hole in lock cap.

2. While holding plunger in, turn key approximately 20° counterclockwise to release lock cylinder and remove cylinder from switch.

3. To install lock cylinder, insert key in cylinder. Then, with key and cylinder turned about 20° counterclockwise, insert cylinder in lock and rotate clockwise to lock in place.

### FREE UP LOCK

Occasionally an ignition lock may stick, making it difficult to insert key and turn lock. In such case, blow a very small quantity of powdered graphite into the lock key hole and operate lock several times to free up.

## IGNITION SYSTEM TROUBLE DIAGNOSIS

### *QUICK CHECKS*

If the engine does not run, the ignition system is at fault if:

1. There is no spark during cranking, when a spark plug wire is held 1/4 inch from the engine.

2. The engine starts but immediately stops when the ignition switch is released from the "Start" position.

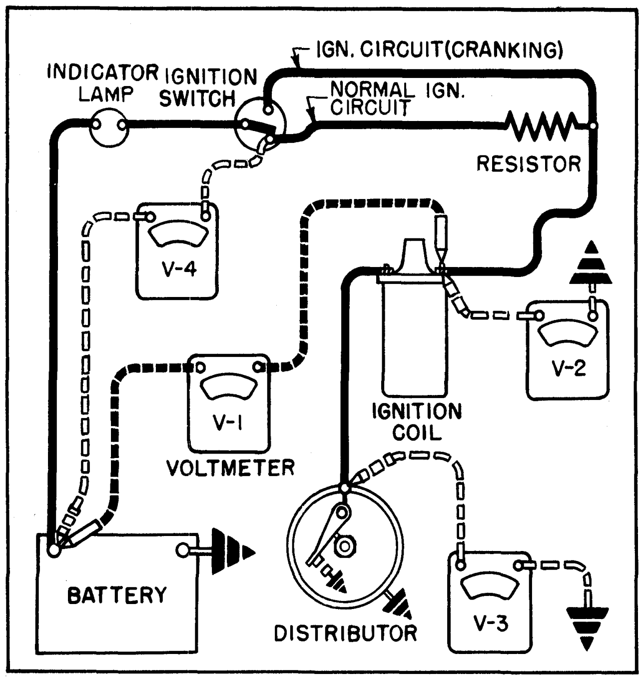



Fig. 11-65 Testing Diagram for Ignition Circuit

### DIAGNOSIS PROCEDURE

If the ignition system is at fault, the following checks will help locate the difficulty. All checks are to be made with the lights and accessories off and in the sequence shown. Voltage readings referred to are indicated in Fig. 11-65.

If these checks fail to find cause of trouble—remove distributor, coil, and resistance wire from engine and check to specifications. Also check wiring harness.

| OPERATION | SPECIFICATION | POSSIBLE TROUBLE |
|---|---|---|
| Check all connections in primary and secondary circuit. | | |
| Remove secondary coil lead from distributor cap. Hold 1/4 inch from engine while cranking, and observe if spark occurs. | | If spark occurs:<br>Distributor cap.<br>Rotor.<br>Spark plug wiring. |
| Check Voltage $V_1$ while cranking. | 1 Volt Max. | Open circuit from battery side of coil to solenoid switch.<br>Solenoid switch not closing ignition circuit.<br>Ground in circuit from coil terminal to solenoid switch.<br>Ground in coil. |
| Check Voltage $V_2$ ignition switch "On", points open. | Normal Battery Voltage. | Low battery.<br>Points not open.<br>Ground in circuit from coil to distributor.<br>Ground in distributor.<br>Ground in coil.<br>Ground in circuit from coil to solenoid switch or to resistor. |
| Check Voltage $V_2$ ignition switch "On", points closed. | 5 to 7 Volts. | If over 7 volts check following:<br>Contacts not closed.<br>Loose connection in distributor.<br>Distributor not grounded to engine. |

| OPERATION | SPECIFICATION | POSSIBLE TROUBLE |
|---|---|---|
| | | Faulty contacts. |
| | | Loosen connection between coil and distributor. |
| | | Resistance out of circuit due to shorted or incorrect wiring. |
| | | Solenoid switch contacts stay closed. |
| | | Wire resistor has too little resistance. |
| | | Coil primary is open. |
| | | If under 5 volts, check following: |
| | | Loose connections between battery and resistor. |
| | | Loose connections between resistor and coil. |
| | | Resistor open or has excessive resistance. |
| Check Voltage $V_3$ ignition switch "On", points closed. | 0.2 Volts Max. | Contacts not closed. |
| | | Loosen connection in distributor. |
| | | Distributor not grounded to engine. |
| | | Faulty contacts—if faulty, recheck voltage $V_2$ ignition switch on, points closed. |
| Check Voltage $V_4$ ignition switch "On", points closed. | 0.7 Volts Max. | Loose connection from wire resistor through ignition switch circuit to battery. |

# TRANSISTOR IGNITION CIRCUIT

## DESCRIPTION

The transistor ignition system features a specially designed distributor, control unit (ignition pulse amplifier), and a special coil. The other units in the system (the resistance wire, switch, spark plugs, and battery) are of standard design. The distributor and control unit (ignition pulse amplifier) are shown in Figs. 11-66 and 11-67.

Although the external appearance of the distributor resembles a standard distributor, the internal construction is quite different. As shown in the partially exploded view of Fig. 11-68, an iron timer core

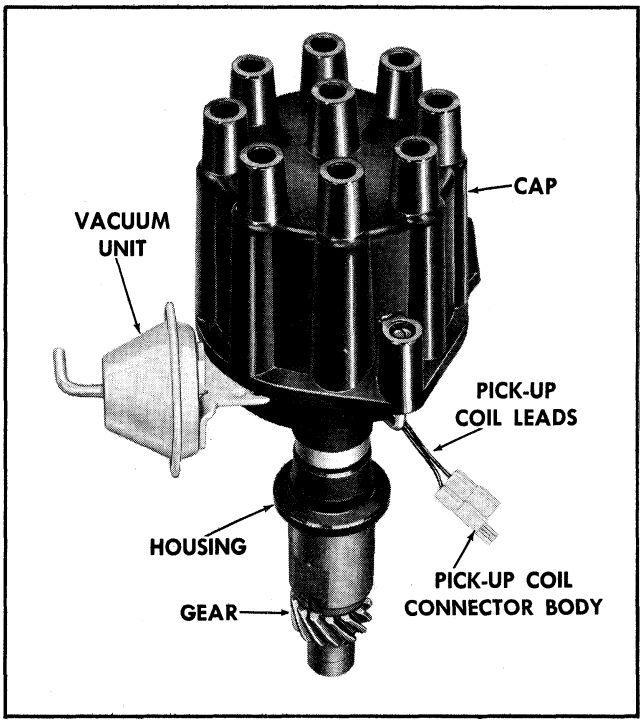



Fig. 11-66 Distributor

replaces the conventional breaker cam. The timer core has the same number of equally-spaced projections, or vanes as engine cylinders.

The timer core rotates inside a magnetic pick-up assembly, which replaces the conventional breaker plate, contact point set, and condenser assembly. The magnetic pick-up assembly consists of a ceramic permanent magnet, a pole piece, and a pick-up coil. The pole piece is a steel plate having equally spaced internal teeth, one tooth for each cylinder of the engine.

The magnetic pick-up assembly is mounted over the main bearing of the distributor housing, and is made to rotate by the vacuum control unit, thus providing vacuum advance. The timer core is made to rotate about the shaft by conventional advance weights, thus providing centrifugal advance.

The electronic control unit consists primarily of transistors, resistors, diodes and condensers mounted onto a printed circuit panel board. Since there are no moving parts, the control unit is a completely static assembly. The operating principles of the distributor and control unit are covered below.

### *OPERATING PRINCIPLES*

A wiring diagram showing the complete circuit for the transistor ignition system is illustrated in

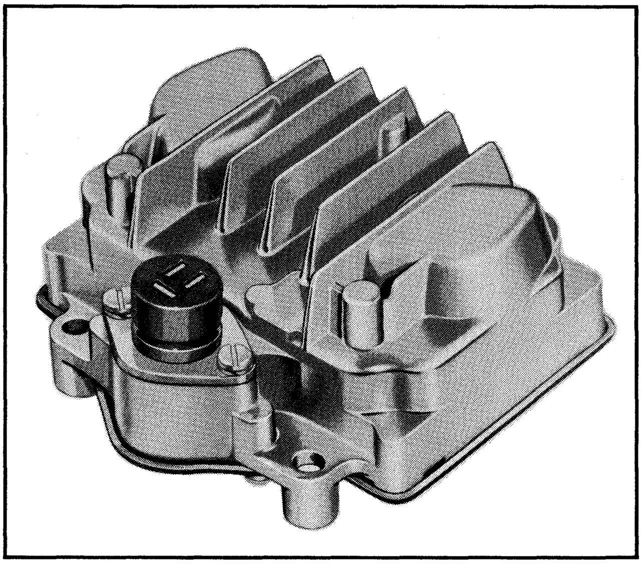


Fig. 11-67 Control Unit (Ignition Pulse Amplifier)

Fig. 11-69. Note that there are two separate resistance wires used in this type of circuit. The resistance wire connected directly to the switch is by-passed during cranking, whereas the other resistance wire is always in the circuit. The use of two resistance wires permits the required value of resistance to be by-passed during cranking.

In order to fire the spark plug, it is necessary to induce a high voltage in the ignition coil secondary winding by closing and opening the circuit to the

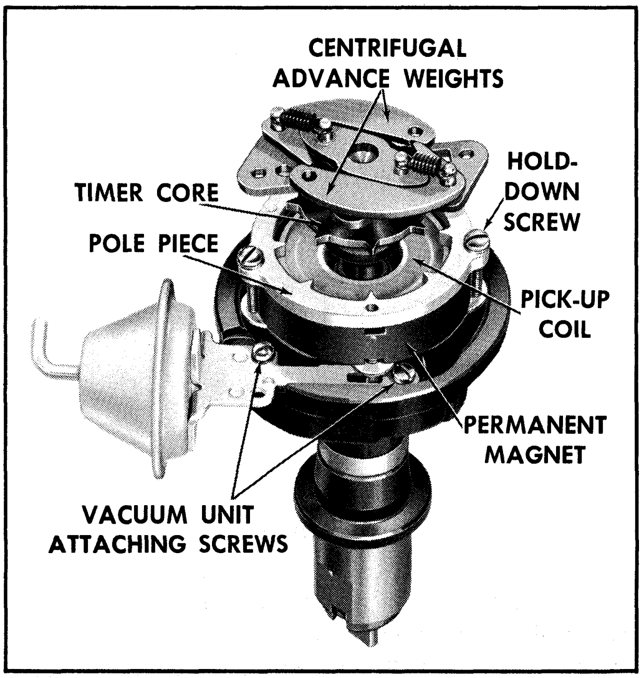



Fig. 11-68 Distributor - Exploded View

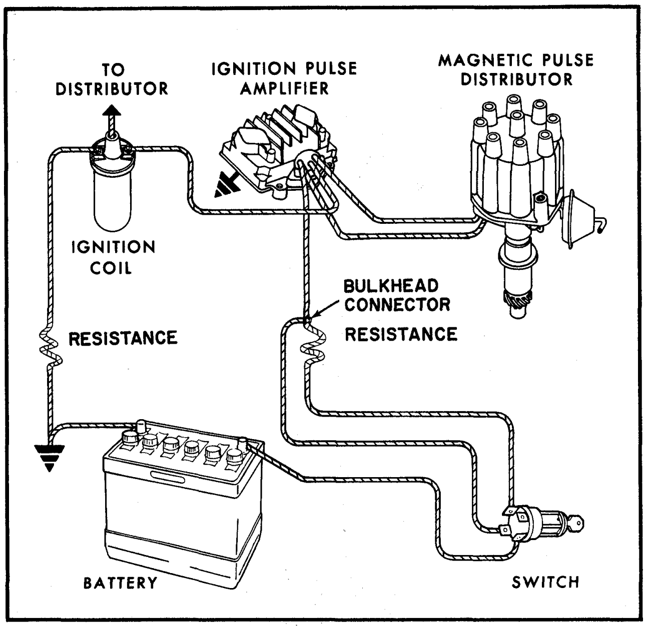



Fig. 11-69 Ignition Circuit Schematic

coil primary winding. In standard systems, this is accomplished by closing and opening the distributor contact points. In the transistor ignition system, this is accomplished as follows:

When the switch is closed, with the engine not running, current flows through a part of the circuit as shown in Fig. 11-70. In this wiring diagram, the components shown within the dashed lines are housed in the control unit. The current can be traced from the battery through the switch and resistance wire (R-5) to the control unit. Current then flows through transistors TR-1 and TR-2, inductor L-1, resistors R-1, R-2 and the coil primary winding and resistance wire (R-6) to ground, thus completing the circuit back to the battery. It is important to note that under this condition full current flows through the coil primary winding, and capacitor C-1 is charged with the positive voltage towards transistor TR-2.

When the engine is running, the vanes on the rotating iron core in the distributor line up with the internal teeth on the pole piece. This establishes a magnetic path through the center of the pick-up coil, causing a voltage to be induced in the pick-up coil. This voltage causes transistor TR-3 to conduct, resulting in current flow in the circuit as shown in Fig. 11-71.

The charge on capacitor C-1 causes transistor TR-2 to turn off, which in turn causes transistor TR-1 to turn off. This interrupts the circuit to the ignition coil primary winding, and the high voltage needed to fire the spark plug is induced in the coil secondary winding. These current conditions are shown in Fig. 11-71.

The current conditions shown in Fig. 11-71 exist until the charge on capacitor C-1 has been dissipated through resistor R-2. When this happens,

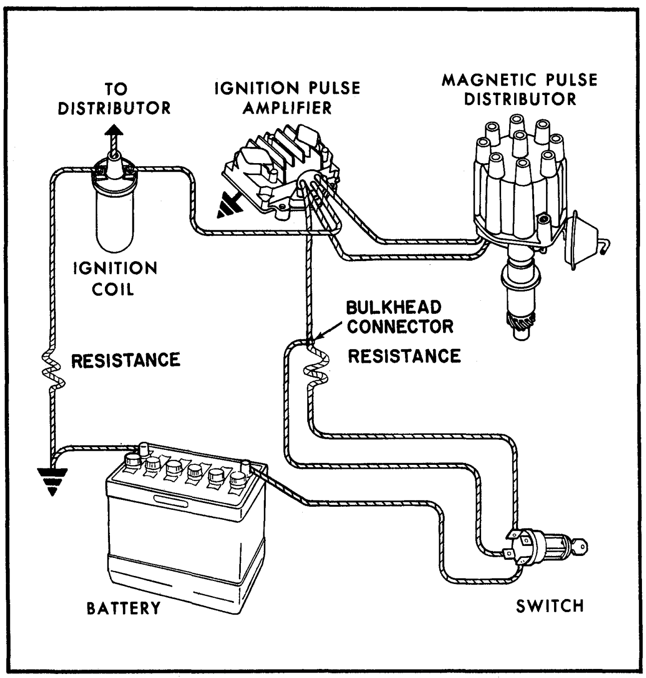



Fig. 11-70 Current Flow Schematic

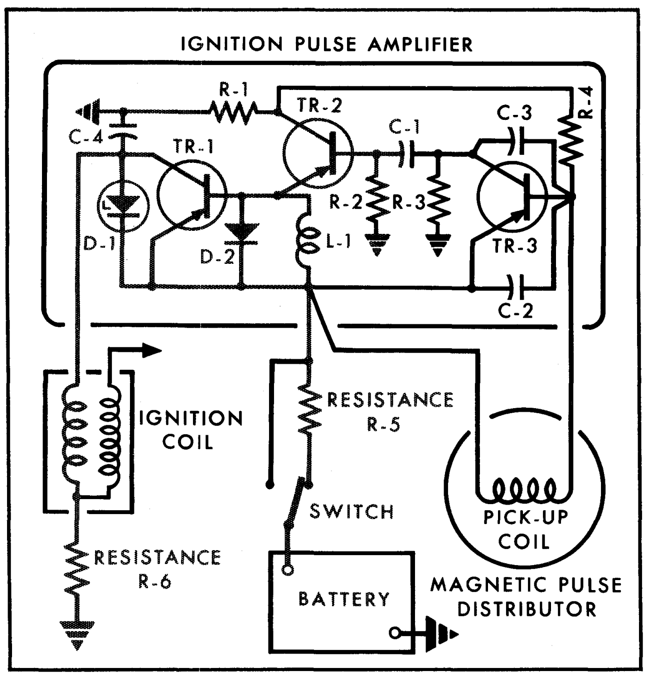



Fig. 11-71 Current Flow Schematic

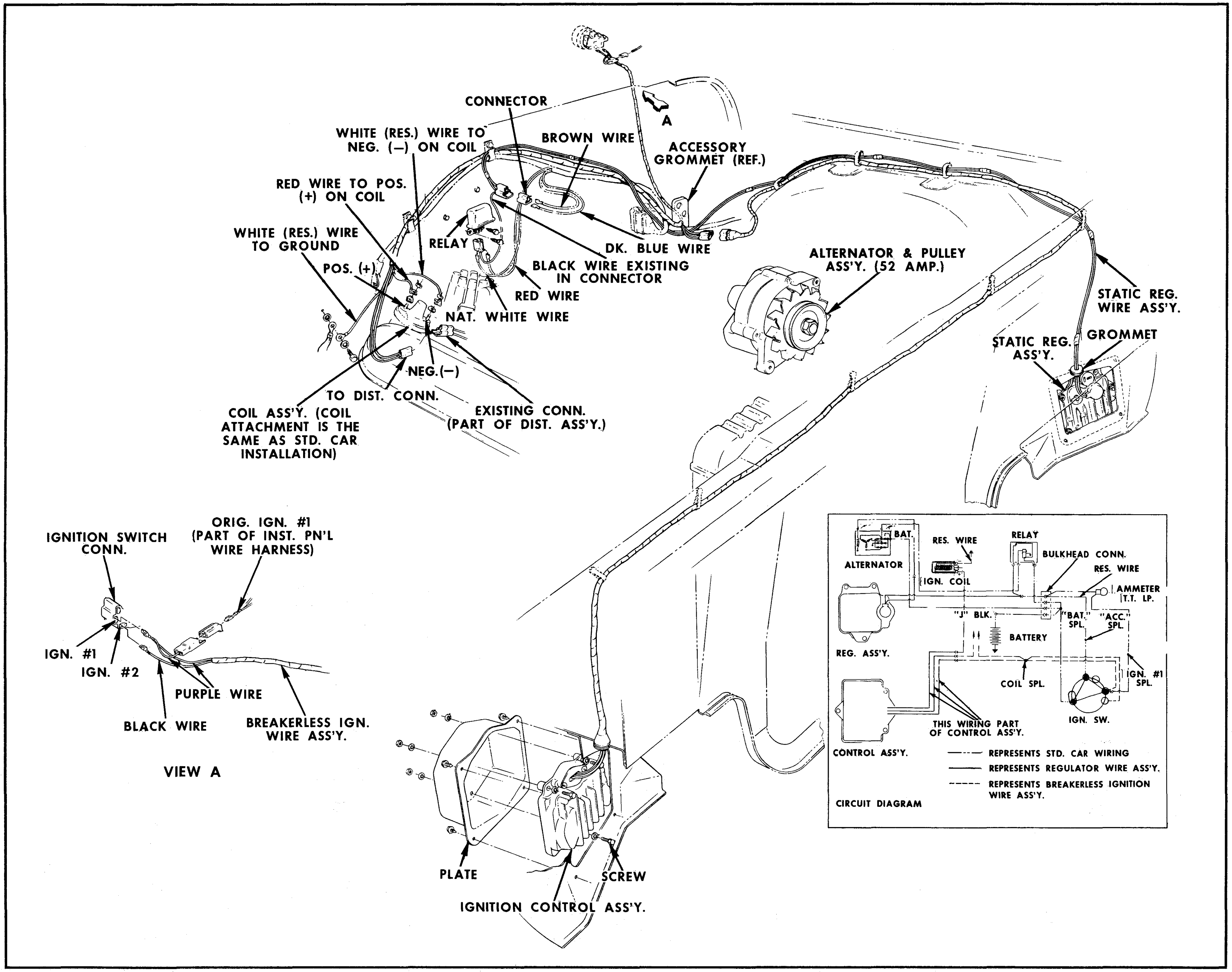



Fig. 11-72 Installation - Transistorized Ignition

the system reverts back to the current flow conditions shown in Fig. 11-70. The system is then ready to fire the next spark plug.

Reistor R-4 is called a feed-back resistor, and its purpose is to turn TR-3 off when TR-2 returns to the "on" condition. Zener diode D-1 protects transistor TR-1 from high voltage which may be induced in the coil primary winding. Capacitors C-2 and C-3 protect transistor TR-3 from high voltages which appear in the system. Inductor L-1 and diode D-2 operate to help turn off transistor TR-1 and capacitor C-4 reduces the amount of power that transistor TR-1 must dissipate.

## PERIODIC SERVICE

Since the control unit is completely static, and the distributor shaft and bushings have permanent-type lubrication, no periodic maintenance is required. The distributor lower bushing is lubricated by engine oil through a splash hole in the distributor housing, and a housing cavity next to the upper bushing contains a supply of lubricant which will last between engine overhaul periods. At time of engine overhaul, the upper bushing may be lubricated by removing the plastic seal and then adding SAE 20 oil to the packing in the cavity. A new plastic seal will be required since the old one will be damaged during removal.

## REMOVE DISTRIBUTOR

1. Disconnect pick-up coil connector body.

2. Remove distributor cap.

3. Crank engine so rotor is in position to fire No. 1 cylinder and timing mark on harmonic balancer is indexed with pointer.

4. Remove vacuum line from distributor.

5. Remove distributor clamping screw and hold-down clamp.

6. Remove distributor and distributor to block gasket. It will be noted that the rotor will rotate as the distributor is pulled out of the block. Note the relationship of the rotor and the distributor housing after removal so that the rotor can be set in the same position when the distributor is being installed.

## DISASSEMBLE DISTRIBUTOR

1. Remove distributor cap.

2. Remove screws securing rotor and remove rotor.

3. Remove centrifugal weight springs, if necessary.

4. Remove centrifugal weights.

5. Remove roll pin.

6. Remove drive gear and washer.

7. Remove drive shaft.

8. Remove weight support and timer core from drive shaft.

9. Remove screws securing magnetic core assembly and remove assembly.

10. Remove connector from primary lead, by disengaging leads from connector.

11. Remove coil assembly.

12. Remove retaining ring which secures magnetic core support plate and remove plate.

13. Remove brass washer and felt.

14. Remove vacuum advance unit.

## ASSEMBLE DISTRIBUTOR

To assemble, reverse above procedure.

## INSTALL DISTRIBUTOR

1. Check to see that engine is at firing position for No. 1 cylinder (No. 1 piston at top of compression stroke) and timing mark on harmonic balancer is indexed with pointer (Fig. 11-63).

2. Position new distributor to block gasket on block.

3. Install distributor in block so that vacuum diaphragm faces the left side of the engine and rotor points toward contact in cap for No. 1 cylinder.

Before installing distributor, index rotor with housing as noted when distributor was removed. This will simplify indexing the distributor shaft and gear with the oil pump drive shaft and the drive gear on the camshaft. Distributor and rotor will be positioned as shown in Fig. 11-59 when properly installed with No. 1 piston in firing position.

4. Replace distributor clamp leaving screw loose enough to allow distributor to be turned for timing adjustment.

5. Install spark plug wires in distributor cap. Place wire for No. 1 cylinder in tower (marked on old cap during disassembly) then install remaining wires counterclockwise around the cap according to the firing order (1-8-4-3-6-5-7-2).

6. Attach distributor to coil primary wire.

7. Replace distributor cap.

8. Adjust dwell and timing and then tighten distributor clamp screw.

9. Attach vacuum line to distributor.

## REGULATOR AND CONTROL UNITS—REPLACE

Refer to Fig. 11-72 which shows installation of these units.

## TROUBLE DIAGNOSIS

Faulty engine performance usually will be evidenced by one of the following three conditions.

1. Engine miss

2. Engine surge

3. Engine will not run at all

When troubleshooting the system, it is recommended that the following checks be made in the order listed.

### *ENGINE MISS*

If the trouble is not due to carburetion, check the ignition system as follows:

TIMING

The timing should be checked in accordance with the specifications on page 11-47.

SPARK PLUGS

Removal of the spark plugs followed by a visual inspection will often reveal conditions which may adversely offset ignition performance. Spark plug servicing is covered on page 11-43.

WIRING

All the wiring should be visually inspected for brittle or cracked insulation, broken strands, and loose or corroded connections. The high tension leads in the coil and distributor cap should be checked to make sure they are pressed all the way down in their inserts. If rubber boots are used, they too should be tightly in place over the connections. Also, the outside of the distributor cap and the coil cover should be inspected for carbonized paths which would allow high tension leakage to ground. Also, remove the distributor cap so the rotor and inside of the cap can be checked for cracks and carbonized paths.

DISTRIBUTOR

The pick-up coil in the distributor may be checked by separating the harness connector and connecting an ohmmeter across the coil. The resistance of the coil should be 550-650 ohms. If the reading is infinite, the coil is open, and if the reading is low, the coil is shorted. Remember that the resistance of the coil will increase slightly as the coil temperature rises.

Also, the pick-up coil may be checked for grounds by connecting the ohmmeter from either coil lead to the distributor housing. The reading should be infinite. If it is not, the coil is grounded.

The distributor centrifugal and vacuum advance may be tested in a distributor testing machine or synchroscope specially designed to accommodate this type of distributor as recommended by the machine manufacturer. However, since this involves removing the distributor from the engine, this test may be postponed until after the remaining circuit checks, as covered below, have been completed. It is not likely that the centrifugal or vacuum advance will be a cause of trouble.

IGNITION COIL

The ignition coil primary can be checked for an open condition by connecting an ohmmeter across

the two primary terminals. An infinite reading indicates the primary is open. For the engine to run but miss at times, the primary open must be of the intermittent type.

Also the coil secondary can be checked for an open by connecting an ohmmeter from the high tension center tower to either primary terminal. To obtain a reliable reading, a scale on the ohmmeter having the 20,000 ohm value within, or nearly within, the middle third of the scale must be used. If the reading is infinite, the coil secondary winding is open.

A number of different types of coil testers are available from various test equipment manufacturers. When using these testers, follow the procedure recommended by the tester manufacturer. (NOTE: Make sure the tester will properly check this special coil.)

### *CONTROL UNIT (IGNITION PULSE AMPLIFIER)*

If all previous checks are satisfactory, and the control unit is properly grounded, the engine miss is probably caused by a malfunction of the control unit. Replacement of the control unit will determine if the original unit is malfunctioning.

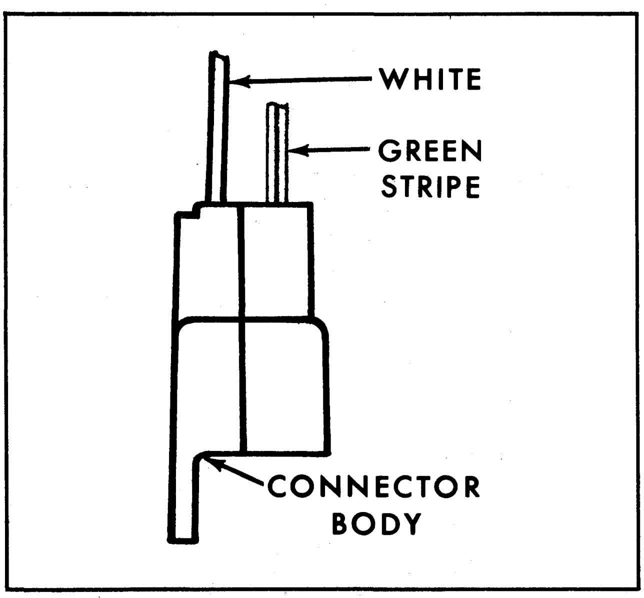



Fig. 11-73 Connector Body

### *ENGINE SURGE*

An engine surge condition, of a nature much more severe than that characterized by a lean carburetor, may be due to the two distributor leads being reversed in the connector body, or may be due to an intermittent open in the distributor pick-up coil.

When properly assembled, the distributor white and black leads are located in the connector body as shown in Fig. 11-73. If the leads are reversed, a severe surge condition will prevail.

Also, a surge condition may result from the action of the vacuum unit causing a break in the distributor pick-up coil wiring to intermittently open and close. To check this, disconnect the vacuum line, and observe engine behavior at idle speed.

### DISTRIBUTOR

To complete the checks on the pick-up coil, connect an ohmmeter to the two distributor pick-up coil lead terminals in the connector body. The resistance should be 550-650 ohms. If the resistance is infinite, the coil is open, and if the resistance is low, the coil is shorted. Also connect the ohmmeter from either terminal to the distributor housing. The reading should be infinite. If not, the winding is grounded.

### ENGINE WILL NOT RUN AT ALL

If the engine will not run, remove the lead from one of the spark plugs and hold about 1/4" from the engine block while cranking the engine. If a spark occurs, the trouble most likely is carburetion. If a spark does not occur, check the ignition system as follows:

### WIRING

All the wiring should be visually inspected for brittle or cracked insulation, broken strands, and loose or corroded connections. The high tension leads in the coil and distributor cap should be checked to make sure they are pressed all the way down in their inserts. If rubber boots are used, they too should be tightly in place over the connections. Also, the outside of the distributor cap and the coil cover should be inspected for carbonized paths which would allow high tension leakage to ground. Also, remove the distributor cap so the rotor and inside of the cap can be checked for cracks and carbonized paths.

IGNITION COIL

The ignition coil primary can be checked for an open condition by connecting an ohmmeter across the two primary terminals. An infinite reading indicates the primary is open.

Also the coil secondary can be checked for an open by connecting an ohmmeter from the high tension center tower to either primary terminal. To obtain a reliable reading, a scale on the ohmmeter having the 20,000 ohm value within, or nearly within, the middle third of the scale must be used. If the reading is infinite, the coil secondary winding is open.

A number of different types of coil testers are available from various test equipment manufacturers. When using these testers, follow the procedure recommended by the tester manufacturer.

CONTINUITY

Further checks for continuity can be made by connecting a voltmeter from the ignition coil positive terminal to ground as shown in step 1 in Fig. 11-74. Turn the ignition switch, and observe the reading.

1. If reading is approximately 8-9 volts, proceed to next section entitled "Distributor."

2. If reading is battery voltage, there is an open in the circuit between this point and ground. This

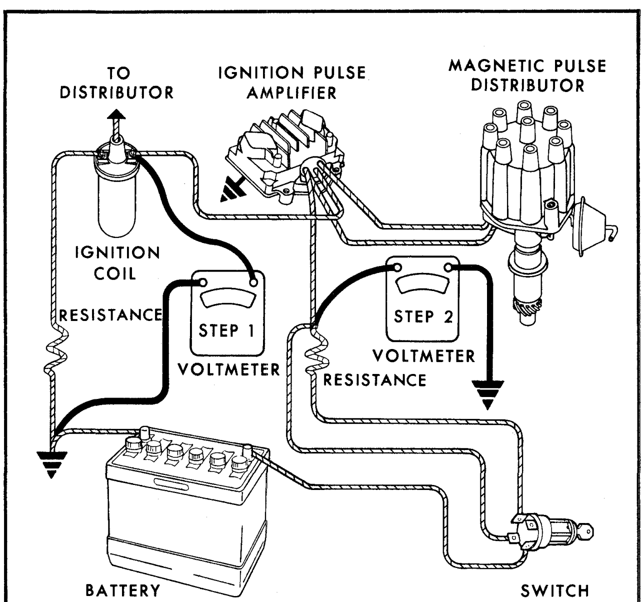



Fig. 11-74 Continuity Check

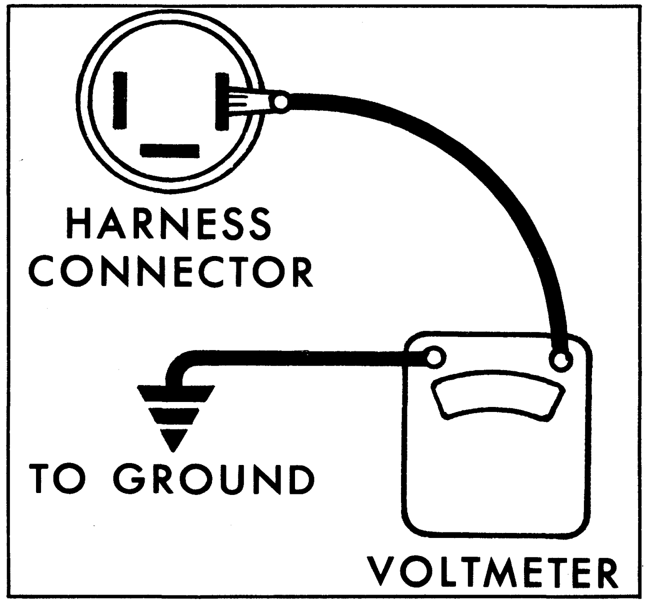



Fig. 11-75 Voltmeter Attached to Ignition Pulse Amplifier Harness Connector

circuit consists of the coil primary winding resistance wire, and wiring.

3. If reading is zero, there is an open in the circuit between this point and the battery. Proceed as follows:

Detach the resistance wire harness connector from the control unit (ignition pulse amplifier) and connect a voltmeter to the harness connector and ground as shown in Fig. 11-75. Then observe the reading with the switch on.

a. If the reading is zero there is an open between this point and the battery. This circuit consists of the resistance wire, the ignition switch, and the wiring.

b. If the reading is battery voltage, there is an open in the circuit between control unit and the ignition coil. This circuit consists of the control unit and the wiring. If the wiring checks satisfactorily, replace the control unit.

DISTRIBUTOR

The pick-up coil in the distributor may be checked by separating the harness connector and connecting an ohmmeter across the coil. The resistance of the coil should be 550-650 ohms. If the reading is infinite, the coil is open, and if the reading is low,

the coil is shorted. Remember that the resistance of the coil will increase slightly as the coil temperature rises.

Also, the pick-up coil may be checked for grounds by connecting the ohmmeter from either coil lead to the distributor housing. The reading should be infinite. If it is not, the coil is grounded.

If the distributor checks satisfactorily, replace the control unit.

# LIGHTING AND HORN POWER CIRCUITS

## DESCRIPTION

### FUSE BLOCK

The fuse block (Fig. 11-76) has replaceable fuse clips which are serviced separately. An efficient tool for fuse clip removal can be made from a cotter pin approximately 2-1/2 inches long. Cut off long leg even with short leg. File a bevel on the outside of both legs. Spread the pin wide enough to span the fuse clip.

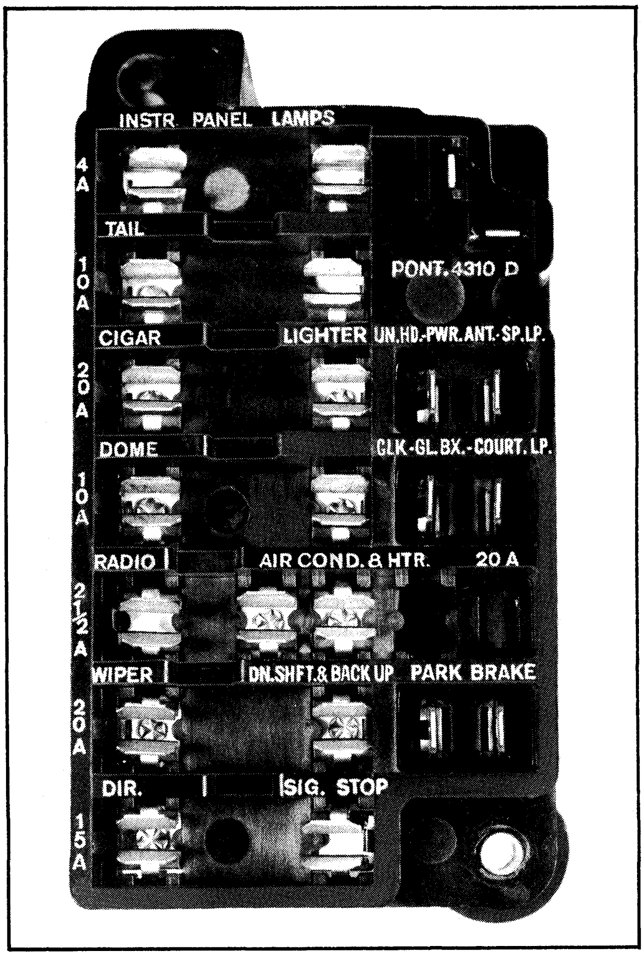



Fig. 11-76 Fuse Block

To remove fuse clip, insert cotter pin over center of fuse clip (Fig. 11-77) and push in to disengage locking ears on both sides of clip. Continue pushing after ears disengage and fuse clip will come out through fuse block.

*NOTE: Fuse and light applications can be found in the specification tables at the end of this section.*

### WIRING HARNESS

The wiring harness routing has clip retainers to reduce the possibility of damage to the harness. Particular attention should be given toward making sure that the wiring is not pinched, stretched, or positioned so as to contact any movable parts under the instrument panel. This includes the hand brake, foot brake, ash trays, accelerator linkage or the heater linkage. In the engine compartment the following routing should be checked: wires to generator, wires in clip retainer opposite carburetor choke heat tube, around regulator, horn relay, battery, starter solenoid, large dash clips, and the large dash grommet.

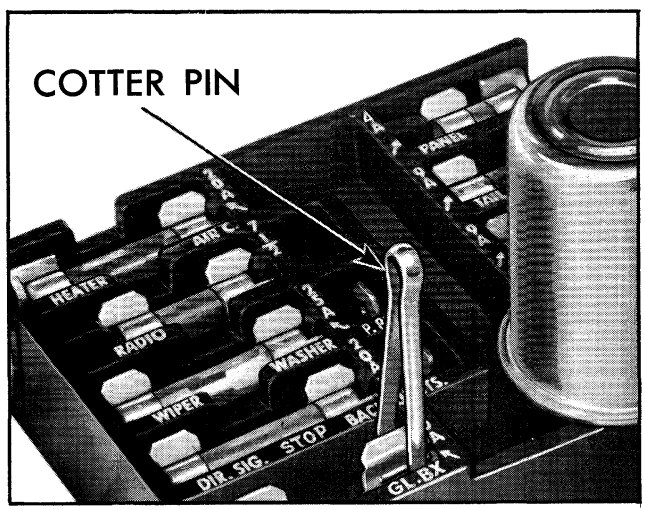



Fig. 11-77 Removing Fuse Clip

### WIRING CONNECTORS

Wiring connectors have a locking design to insure a tight fit and to prevent them from separating.

*NOTE: When servicing the connector, insert a thin bladed screwdriver between the male and female section to unlock the assembly before pulling it apart.*

### LIGHTING

The headlight system consists of two dual headlight units mounted in a horizontal arrangement on each side of the car. In this installation the outboard light is a dual filament seal beam unit. The inboard unit contains a single filament and is used as the primary source of light for the high beam.

When driving with low beam only the low beam filament of the outboard lights is used. On high beam all four lights are used.

Lighting is controlled by two switches. First, the instrument panel main lighting switch which has two "on" positions or notches, the first for parking, tail and license lights, and the extreme out position for the headlights, tail and license lights. Rotating the lighting switch knob operates a rheostat for dimming the instrument panel lights; with the rheostat in the extreme counterclockwise position the instrument panel lights are completely off and the dome light is turned on. Second, the headlight beam switch (foot operated) determines if the headlight country (bright) beam or traffic (dim) beam is on when the main lighting switch is pulled out. A red indicator lamp on the speedometer shows when the headlight country beam is on.

Parking lights use a two filament bulb. One filament is for the directional signal and the other is for the parking light.

Headlights are of sealed beam construction so that the light source, reflector, lens, and lens gasket are all assembled in one sealed unit. When the filament burns out or the lens is cracked or broken, the entire unit is readily replaceable with a new unit.

The filaments used in the twelve volt headlights are very fragile. Therefore, these headlight units must be handled carefully.

### HEADLIGHT AIMING

Preparation of car for aiming operation includes:

1. Make sure car is in good horizontal and vertical alignment with aiming test equipment.

2. Jounce car to equalize suspension.

3. Make sure the aiming is performed with car at curb height (see Section 3).

4. Tires should be inflated uniformly to recommended pressure (see Section 3A).

Aiming screen data is contained in Fig. 11-78. When aiming upper beam the pattern of only the inboard upper beam units is to be used.

The hot spot of each light shall have relationship to the vertical and horizontal center line of the individual light unit within the limits and conditions shown in Fig. 11-78 at a distance of 25 feet.

### TAIL LIGHT

The tail light bulb is a double filament bulb which acts as a stop light, tail light and turn signal light. The bulb can be removed from the inside of the trunk.

### STOP LIGHT SWITCH

The stop light switch must be checked whenever the brake pedal height has been changed. Adjustment is made by positioning the switch and bracket in relation to the pedal arm.

*NOTE: Make sure that the switch does not restrict pedal action.*

### HORNS (Fig. 11-79)

The horn used on the car uses a solenoid actuated diaphragm to develop a resonating air column in the horn projector.

A relay is used in the horn circuit because of the high current required to operate the horn. The relay reduces the length of heavy gauge wire required and makes a more direct connection between the horn and the battery. Consequently, higher voltage is available at the horn and better performance

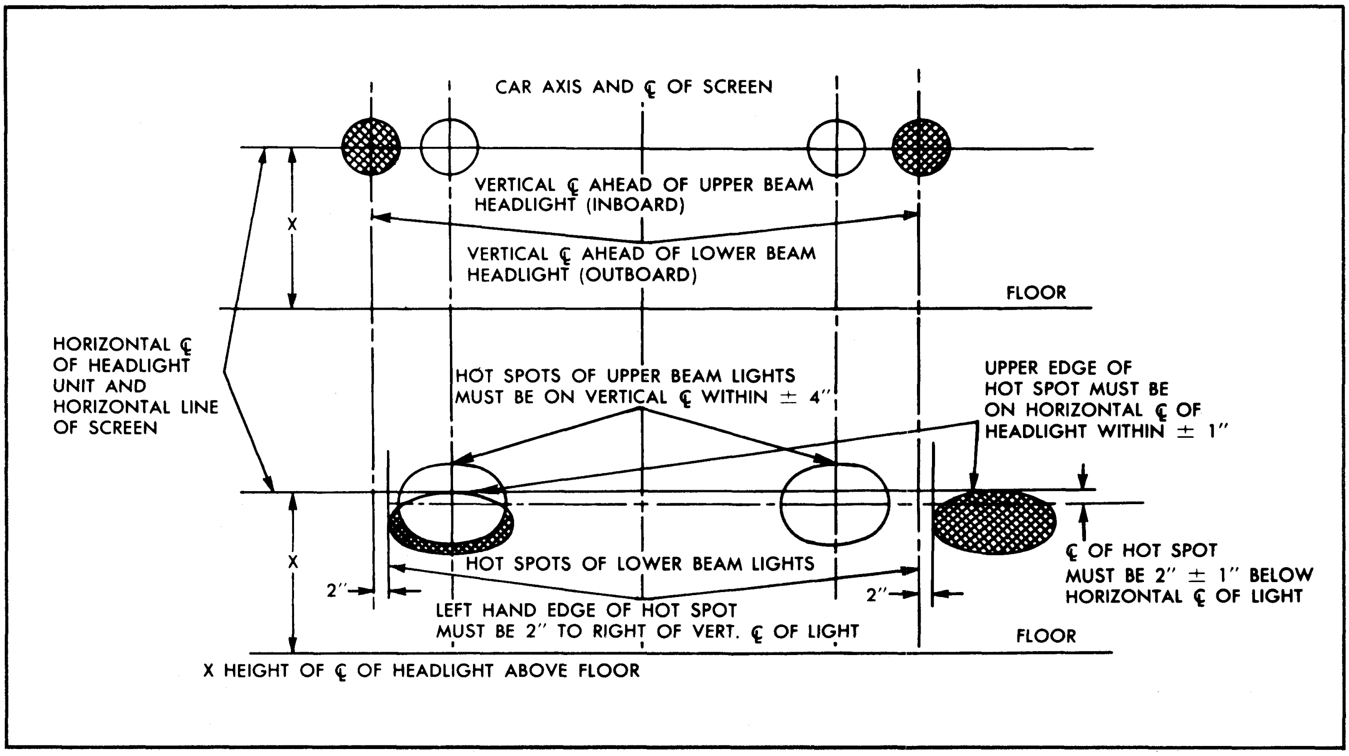



Fig. 11-78 Headlight Aiming Screen Chart

is obtained by eliminating the voltage drop which otherwise would be in the horn button wiring circuit.

A second horn is available as optional equipment. It is designed to give a blended tone with other horn.

### CIGAR LIGHTER

The cigar lighter releases automatically (usual time for release is 10 to 14 seconds) which means that if the plug assembly for some reason is held in by the operator's hand a sufficient length of time

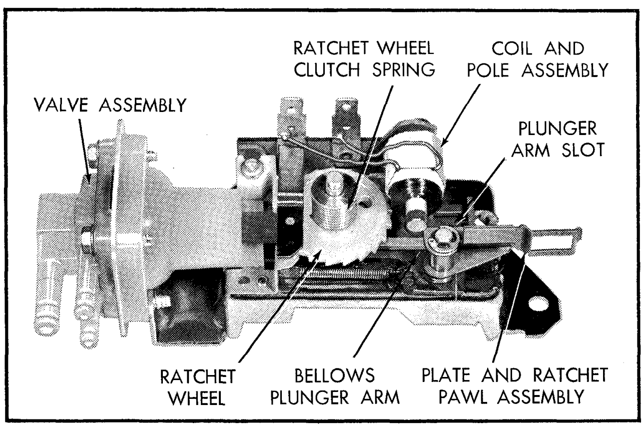



Fig. 11-79 Horns

(60 to 90 seconds), the fuse will blow or circuit breaker contact button will release. This may in some cases account for a blown fuse or released circuit breaker contact button where none of the other parts of the lighters are defective.

If temperature of the element shows indications of incorrect timing (too hot or too cold), the socket assembly containing the bi-metal hold-in fingers must be replaced.

The lighters have a safety feature in the form of two retaining fingers, which prevent the knob and element assembly from falling out of or popping out of the socket onto the floor. If these fingers do not keep the knob and element assembly from falling out onto floor, the socket assembly should be replaced.

### DIRECTIONAL SIGNAL

The directional signal circuit consists of the switch, flasher, one light in the instrument cluster, the stop light filaments in the rear lights, and the turn signal filaments in the parking lights.

The electrical switch is mounted in the directional signal housing. It is actuated by a lever running to the inside of the directional signal housing.

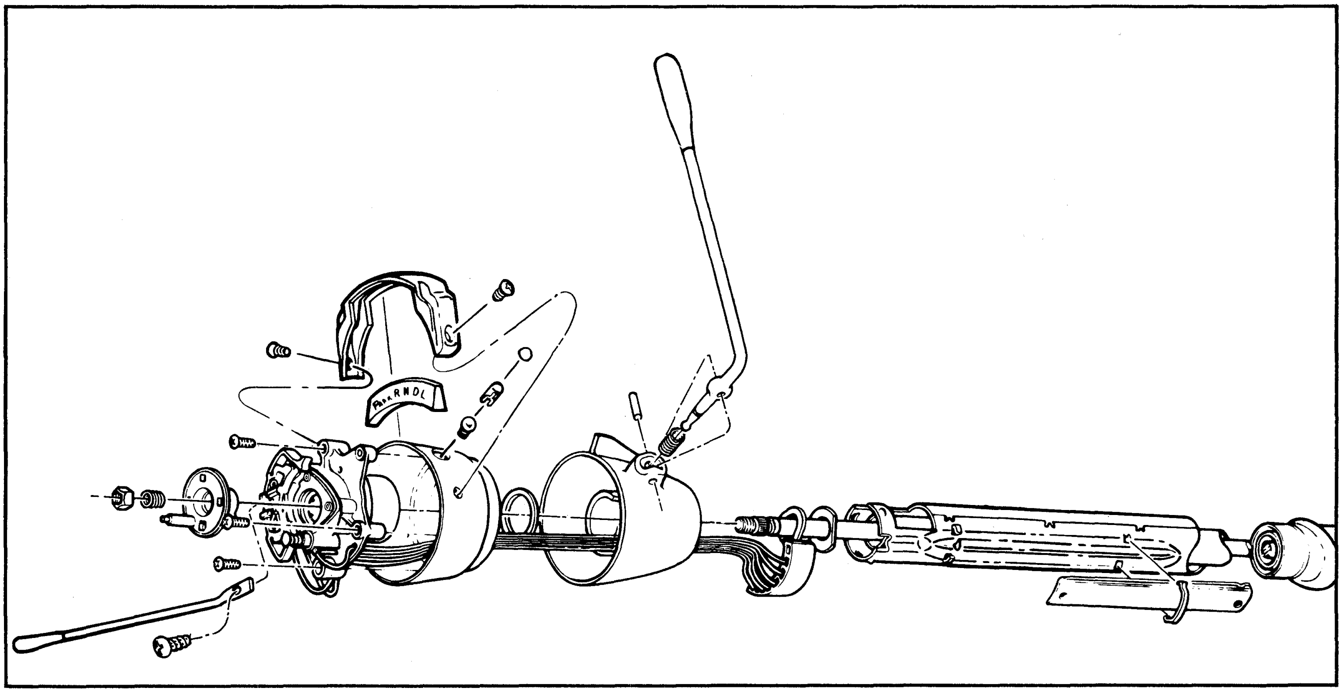



Fig. 11-80 Direction Signal Assembly

The flasher, which is mounted on the fuse block, consists of two sets of points, a coil, and resistor. One set of points controls the flashing of the instrument panel light and the other set controls the flashing of the front and rear lights. The frequency of the turn signal is 80 to 100 flashes per minute.

## SERVICE OPERATIONS

### DIRECTIONAL SIGNAL

REMOVE

1. Remove steering wheel as outlined in Section 9.

2. Disconnect horn wire lead and directional signal connector.

3. Rotate directional signal housing on steering column jacket and remove housing from steering jacket (Fig. 11-80).

INSTALL

1. Install directional signal housing on steering column and position as shown in Fig. 11-81.

2. Install steering wheel as outlined in Section 9.

3. Connect horn wire lead and directional signal connector.

### DIRECTIONAL SIGNAL WIRING

Directional signal schematic wiring diagram is shown in Figs. 11-1, 11-2.

### REPLACE SEALED BEAM UNIT

1. Remove headlight door.

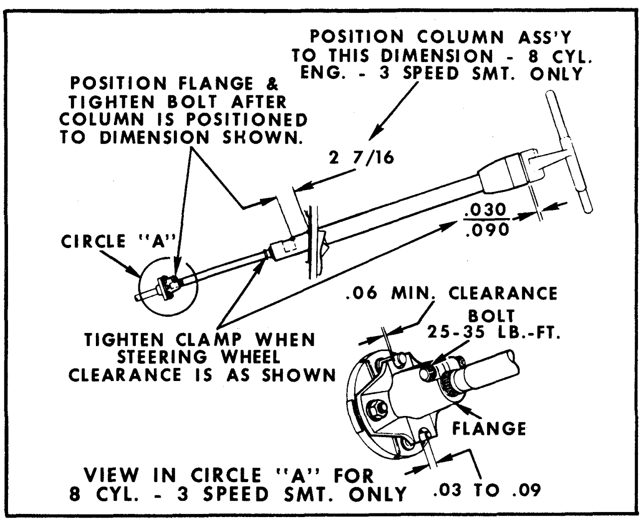



Fig. 11-81 Position for Housing

2. Remove retaining ring and sealed beam unit from mounting.

3. Pull connector from rear of beam unit and separate sealed beam unit from retaining ring.

4. Assemble new sealed beam unit into retaining ring and plug sealed beam unit into connector.

5. Install beam unit and retaining ring.

6. Check headlight aiming and readjust if necessary.

7. If headlight door rubber seal is defective, remove seal and cement new seal securely to door.

8. Replace headlight door.

### REPLACE LIGHT SWITCH

1. Remove one battery cable from battery post.

2. Pull switch knob to headlight "On" position, push latch button on bottom of switch assembly and pull out switch knob assembly.

3. Unscrew ferrule and remove switch assembly.

4. Remove "push-on" connectors from light switch and connect to new switch.

5. Position new switch in instrument panel, and start ferrule into switch assembly. Tighten securely.

6. Insert knob assembly into switch assembly until end of rod engages clutch.

7. Install cable on battery post.

### CIGAR LIGHTER

#### REPLACE ELEMENT

Unscrew element and shield assembly from knob and install new element.

#### REPLACE LIGHTER SOCKET

1. Remove wire connector from rear of lighter socket.

2. Use 1" deep socket to loosen clamping shell. Unscrew lighter socket and remove socket from instrument panel.

3. To install, reverse above procedure, seeing that clamping shell is turned up <u>finger tight only</u> on lighter socket.

## TROUBLE DIAGNOSIS

Troubles in the lighting and horn power circuits are caused by loose connections, open or shorted wiring, or blown fuses. In each, trouble diagnosis requires following through the circuit until the source of difficulty is found. To aid in making an orderly check, refer to Figs. 11-1, 11-2 and 11-3.

### STOP LIGHT INOPERATIVE

| CAUSE | REMEDY |
|---|---|
| Improperly centered directional signal switch. | Center directional signal switch. |

### DIRECTIONAL SIGNAL FAILS TO OPERATE

| CAUSE | REMEDY |
|---|---|
| Blown Fuse. | Replace Fuse. |
| Defective flasher unit. | Replace flasher unit. |
| Loose connection circuit. | Check and tighten connections. |
| Failure of directional signal in left or right parking light or stop light. | Replace light. |

| CAUSE | REMEDY |
|---|---|
| ***INDICATOR LIGHT FLASHES EXTREMELY FAST*** | |
| Defective Flasher. | Replace Flasher. |
| Indicator light does not flash defective bulb. | Replace bulb. |

***HORNS WILL NOT OPERATE***

*NOTE: To locate the trouble the following procedure should be used.*

A. Hold the horn button down to energize horn.

B. While energized, tap horn lightly. If horn fails to blow after tapping, see step G. If horn should start to blow after tapping, proceed to step C.

C. Release horn button so that the horn will stop blowing.

D. Hold horn button down again. If the horn blows normally, a particle of foreign material between the contact points caused the trouble and no adjustment is needed. If the horn still fails to blow until tapped again, adjust in compliance with the next step.

E. To adjust horns which blow only when tapped, turn adjustment screw one full turn counterclockwise with pliers. See Fig. 11-80 for location of adjusting screws.

*CAUTION: This adjustment is sensitive. Do not turn screw more than one full turn or in the wrong direction. Misadjustment will require removing the horn for adjustment on the bench as described in the next section.*

F. Check horn for normal operation and if still inoperative, remove for a bench check.

G. For those horns that will not blow after tapping, check to make sure that voltage is available at the horn terminal or for a good ground connection at the horn mounting. If no trouble is located during these checks and horn is inoperative, remove for a bench check.

1. Bench Checks

a. No current may indicate a broken connection or an open circuit due to a broken lead or overheating. Most horn failures are caused by horns being operated continuously which develops sufficient heat to melt the wires in the winding causing an open circuit. Overheating is accompanied by a characteristic odor which indicates that the horn should be replaced.

b. No current can also indicate that the contact points are open and a current adjustment is required. Turn the adjusting screw counterclockwise.

c. High current over 20 amperes indicates an overheated winding or shorted horn which should be replaced.

d. A reading of approximately 18 amperes for a 12-volt horn indicates a condition in which the contact points are not opening. A current adjustment is required by turning the adjusting screw clockwise.

2. Current adjustment for "Type-C" Horns

Current adjustment is made by turning the adjusting screw counterclockwise to increase the current or clockwise to decrease the current until the specified current is reached. Care must be taken not to turn the adjusting screw too far. Turn only 1/4 of a turn at one time. If adjustment loosens the screw excessively, it may be staked with a prick punch.

The following adjustment of horn current should be made using an automotive type battery and wires that are #16 gauge or larger:

| Voltage Supply | Adjust Horn Current To |
|---|---|
| 11.5-12.5v | 4.5-5.5 amperes |

### HORNS HAVE POOR TONE

| CAUSE | REMEDY |
|---|---|
| A. Harsh tone--caused by loose bolts in sheet metal mounting area. | Tighten Bolts |
| B. Low pitch roar--sounds like "moo-ing" and is caused by too high a current. | Adjust Horn |
| C. Weak tone--caused by too low a current. | Adjust Horn |
| D. Weak strained tone--foreign body in horn trumpet. | Remove Foreign Body |
| E. Harsh vibration--caused by horn touching sheet metal and bracket. | Adjust Bracket for Clearance |

### HORNS BLOW CONSTANTLY

| CAUSE | REMEDY |
|---|---|
| 1. Sticking horn relay. | Replace Relay |
| 2. Horn relay energized by grounded or shorted wiring. | Check and Adjust Wiring |
| 3. Horn button can be grounded by sticking closed. | Adjust of Replace Damaged Parts |

*NOTE: Most horns with burned open windings are caused by one of the above malfunctions. Before replacing horns with open windings with new horns check to make sure that none of the above conditions exist which would again cause the horn winding to burn open.*

## INSTRUMENTS

### DESCRIPTION

Instruments consist of a fuel gauge, temperature indicator light (thermo-gauge), charge indicator light, oil pressure indicator light, and speedometer. Authorized service on the instruments can be obtained through branches of United Motors Service Division and AC Service stations. However, knowledge of instrument circuit checks helps to determine if operating difficulties lie in the instrument itself or in its allied circuit.

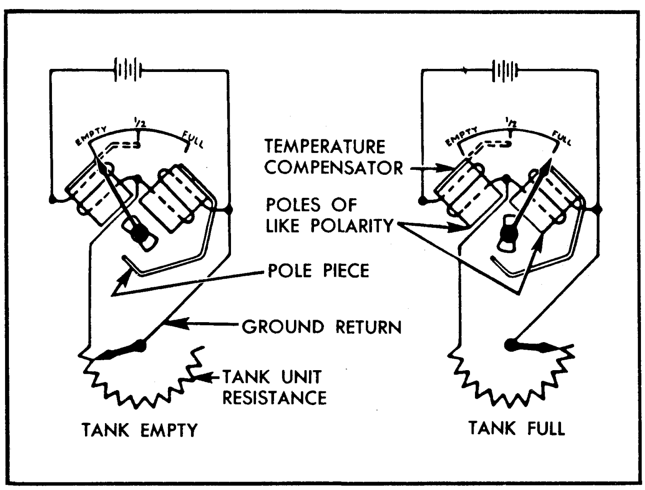



Fig. 11-82 Fuel Gauge Diagram

### FUEL GAUGE

An electric fuel gauge is used on all models. The fuel gause indicates the quantity of gasoline in the tank only when the ignition switch is turned on or to the accessory position. When the ignition is turned off or to start the pointer may come to rest at any position. The letters "E" and "F" on the fuel gauge are used to point out direction of indicator travel only. Gauge readings are made from five markings on the gauge face. The left hand line indicates empty, the center line half-full and the right hand line full. The dash unit of this instrument consists principally of two coils spaced 90° apart, with an armature and pointer assembly mounted at the intersection of the center lines of the two coil end pieces (Fig. 11-82). Silicone liquid in the armature bearing prevents vibration of the pointer on rough roads. One end of the left coil is connected to the left gauge terminal which is connected directly to the battery (through the ignition switch). The other end of the left coil and one end of the right coil are connected to the right gauge terminal which is connected directly to a rheostat which is the fuel gauge tank unit. The other end of the right coil and the tank unit are grounded. The resistance allows more current to flow through the right hand coil as the tank fills up, causing the right hand coil to balance the constant magnetism of the left hand coil, bringing

the pointer and armature assembly to rest somewhere between the two coils, the exact position depending on the relative magnetic strength between the two coils. The fuel gauge tank unit consists of a float, with linkage connecting to a movable contact arm and a rheostat. As the float rises, due to filling the tank, the contact arm moves over the rheostat cutting in resistance and allowing more current to flow through the right hand "full" coil of the panel unit.

### *TEMPERATURE INDICATOR LIGHT*

The engine temperature indicator light is controlled by a thermal switch which senses coolant temperatures.

When the ignition switch is turned to the "Start" position a test circuit is closed to indicate whether the red light is functioning properly.

If the engine cooling system is not functioning properly, the thermal switch will close the circuit to the red light when the engine temperature reaches 248°F. The thermal switch does not require servicing. If it's defective, it should be replaced.

*CAUTION: Low boiling coolants will not operate light.*

### GENERATOR INDICATOR LIGHT

The red generator indicator light, located in the instrument panel, should light when the ignition switch is turned on and the engine is not running. If not, either the bulb is burned out, the generator has an open circuit, or the instrument lamp fuse is blown.

When the generator voltage output becomes greater than the battery voltage, the red light should go out. This does not, however, indicate whether the battery is being charged or the regulator is functioning properly. The charging system should be checked if trouble is experienced.

### ENGINE OIL PRESSURE LIGHT

The engine oil pressure indicator light is controlled by a pressure operated switch located in the oil filter pad.

When the engine is running, the light operates only when the oil pressure is not satisfactory. This light should come on when the ignition is turned "on" and the engine is not running.

The oil pressure switch breaks contact at $5 \pm 1.5$ psi on increasing pressure and makes contact at $5 \pm 1.5$ psi on decreasing pressure.

### SPEEDOMETER

The speedometer incorporates a speed indicating mechanism and an odometer to record total mileage. A flexible cable, which enters the speedometer driven gear in the transmission on one end and the speedometer head at the other, rotates both mechanisms whenever the transmission main shaft, propeller shaft and wheels rotate. The speed indicating portion of the speedometer operates on the magnetic principle. In the speedometer head is a permanent magnet which rotates at the same speed as the cable. This magnet exerts a pull on a speed cup causing it to move in direct ratio to the revolving magnet speed. A pointer is attached to the speed cup spindle to indicate speed on the speedometer dial. A finely calibrated hair spring (also part of the speed cup assembly) opposes the magnetic pull on the speed cup so the pointer indicates true speed; it also pulls the cup and pointer to zero when the car stops.

The odometer is driven by a series of gears from a worm gear cut on the magnet shaft. The odometer discs are so geared that as any one disc finishes a complete revolution, the next disc to the left is turned one-tenth of a revolution.

## PERIODIC SERVICE

No periodic service or librication of instruments (except for the speedometer cable) is required. In fact lubrication of instruments must never be attempted since it will interfere with their satisfactory operation. Never attempt to lubricate the fuel gauge tank unit; adequate lubrication of this unit is provided by splash of the gasoline.

In some cases the speedometer cable becomes noisy or the speed indicator wavers or jerks. This may be due to a dry cable which should be lubricated as outlined in the General Lubrication Section.

## REPAIRS

### *REMOVE INSTRUMENT CLUSTER*

1. Disconnect battery.

2. Remove 10 screws retaining bezel and cluster assembly to instrument panel.

3. Remove speedometer cable.

4. Pull cluster and bezel out from instrument panel opening to gain access to wiring.

5. Starting at the top, remove bulbs and wiring.

6. Remove 4 screws retaining cluster to bezel and remove cluster. To replace, reverse procedure.

### REMOVE AND REPLACE INDIVIDUAL INSTRUMENT (Cluster removed from car)

#### SPEEDOMETER

1. Remove instrument cluster and bezel assembly.

2. Remove screws retaining speedometer head to cluster.

3. Remove screws securing speedometer to head assembly.

4. Replace - reverse steps.

#### FUEL GAUGE

1. Remove instrument cluster and bezel assembly.

2. Remove wire connector and bulb (in car operation).

3. Remove screws.

4. Remove gauge.

5. Replace - reverse steps 1-4.

#### IGNITION SWITCH

See Page 11-47.

#### HEATER CONTROL

See Section 12.

#### FUEL GAUGE TANK UNIT

1. Clean away any dirt that has collected around tank unit so it will not enter tank.

2. Disconnect lead on tank terminal, fuel line and remove tank unit by removing retaining ring.

3. Install new tank unit and check for freedom of float arm movement.

4. Install retaining ring and tighten.

5. Secure terminals and fuel line.

#### SPEEDOMETER CABLE

1. Disconnect speedometer cable casing from speedometer head.

2. Slide old cable from upper end of casing, or if broken, from both ends of casing.

3. Take a short piece of speedometer cable with a tip to fit the speedometer and insert it in the speedometer socket. Spin the short cable between the fingers in the direction that higher speed is indicated on the speedometer dial and not if there is any tendency to bind. If binding is noted, there is trouble inside the head and the speedometer should be repaired.

4. Inspect cable casing, especially at transmission end, for sharp bends and breaks. If breaks are noted, replace casing.

5. Lubricate cable as outlined in General Lubrication Section.

6. Insert cable into upper end of casing, lower end first.

7. Seat upper cable tip in speedometer and tighten casing connector to speedometer case as tightly as possible with fingers.

*NOTE: Insufficient tightening of connector will result in connector loosening, causing speedometer indicator to waver.*

8. See that there are no sharp bends in casing.

## INSTRUMENT TROUBLE DIAGNOSIS

| CAUSE | REMEDY |
|---|---|
| ***GASOLINE GAUGE DOES NOT REGISTER WITH IGNITION ON*** | |
| Break in line between instrument panel unit and ignition switch. | Check line and connections to switch and panel unit. |
| Defective panel unit. | Check and replace. |
| ***GASOLINE GAUGE SHOWS FULL UNDER ALL CONDITIONS*** | |
| Break in line between tank and instrument panel unit. | Check and repair. |
| Defective tank unit. | Check and replace. |
| Tank unit improperly grounded. | Ground tank to chassis and check gauge operation. |
| ***GASOLINE GAUGE SHOWS EMPTY UNDER ALL CONDITIONS*** | |
| Lead to tank unit grounded. | Make necessary repair. |
| Defective tank unit. | Check and replace. |
| Defective panel unit. | Check and replace. |
| ***SPEEDOMETER*** | |
| Noisy speedometer cable. | Loosen over-tightened casing nuts and retighten finger tight at both ends. |
| | Remove kinks from cable. |
| Pointer and Odometer Inoperative. | Remove kinks from cable. |
| | Replace broken cable. |
| | Check for lubricant in speedometer head. |
| Inaccurate Reading. | Check tire size. |
| | Check for correct speedometer driven gear. |
| Cable dry. | Lubricate. |
| Kinked cable. | Replace cable. Reroute casing so that bends have no less than 6" radius. |
| Defective speedometer head. | Replace or have repaired at authorized service station. |
| Casing connector loose on speedometer case. | Tighten connector. |

## INSTRUMENT TESTING

### *FUEL GAUGE TANK AND INSTRUMENT PANEL UNITS*

In order to isolate trouble in the fuel tank or instrument panel unit, use either an extra tank unit, which is known to be good, or commercial gas gauge tester.

*CAUTION: In process of testing fuel gauge panel unit never place full battery current on terminal to which wire to tank is normally attached. To do so will burn out resistance coil in tank even though the terminal is touched only momentarily.*

To test, remove lead to tank unit from instrument panel unit and then use one of the following methods:

### *TESTING WITH EXTRA TANK UNIT*

1. Attach a wire lead from the terminal on the extra tank unit to the tank unit terminal on the panel unit and connect a second wire from body of extra tank unit to car chassis.

2. Turn on ignition and move float on extra tank unit to full and empty positions. If panel unit indicates corresponding reading, it is satisfactory and trouble is in tank unit or wire lead from panel unit to tank unit.

3. Check wiring to tank unit by disconnecting lead from tank unit in car and connecting to test unit. With test unit grounded to chassis, move float to full and empty positions and see that instrument panel unit reads correctly. Incorrect reading indicates defect in wiring.

4. Check tank unit by removing from tank, reconnecting the lead and operating unit in same manner as the test unit (tank unit must be grounded while testing). If instrument panel shows correct reading, trouble was caused by poor connection of lead to tank unit or poor ground. If instrument panel does not give correct reading, install a new tank unit.

### *TESTING WITH TESTER*

The calibration limits of the fuel gauge dash unit are 30 ohms-full, 15-ohms-1/2 full and 1 ohm-empty.

1. Remove lead to tank unit from instrument panel unit. Attach wire of tester to the tank unit terminal on panel unit and ground the tester by connecting the black wire to a good ground.

2. Turn on ignition switch and move lever on tester through its full travel. If panel unit reads "empty" and "full", it is satisfactory and trouble is in tank unit or possibly wire lead from instrument panel unit to tank unit.

3. Check wiring to tank by disconnecting lead from tank unit in car and connecting to tester. Ground tester and move lever on tester through its full travel. If instrument panel unit shows "empty" and "full", tank unit is probably defective and should be checked as in step 4 above.

## ONE SPEED WIPER

### DESCRIPTION

The single speed wiper consists of a shunt wound motor. The gear train consists of helical gear at the end of the armature shaft. The helical gear drives an intermediate gear and pinion assembly, the pinion of which drives an output gear and shaft assembly. The crank arm is attached to the shaft of the output gear. (Fig. 11-83)

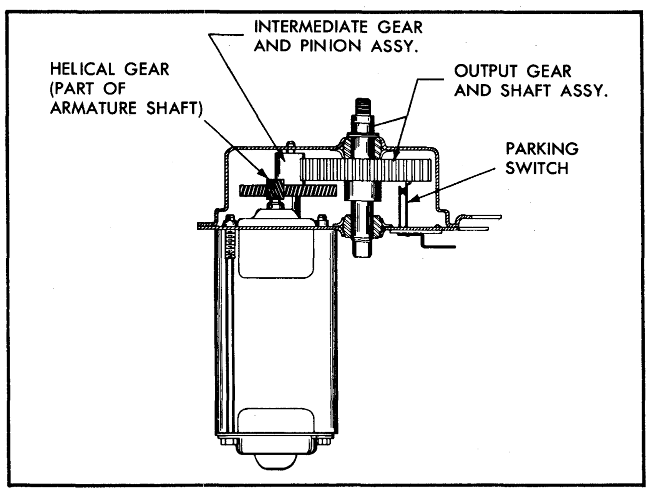



Fig. 11-83 Wiper Gear Train

### OPERATION

Two switches, dash and parking are connected in parallel and control the starting and stopping of the wiper. The park switch contacts, which are located in the wiper gear box (Fig. 11-83), are normally

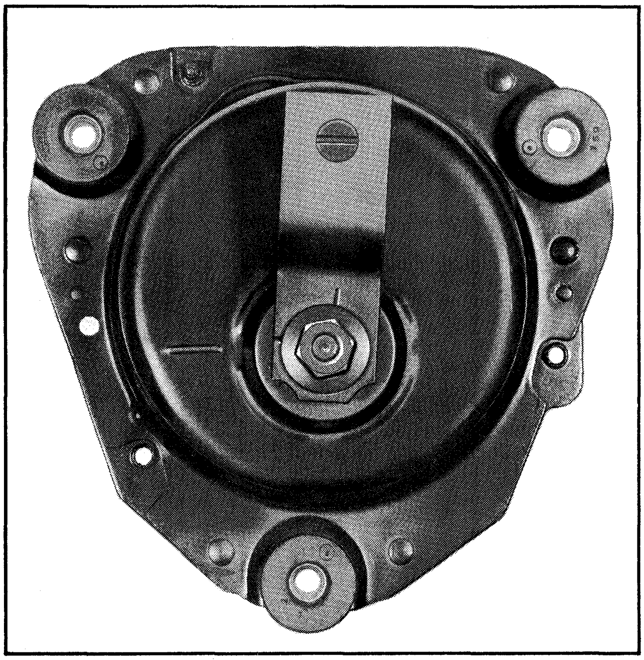


Fig. 11-84 Mounting for Wiper

closed. The purpose of the parking switch is explained in the following paragraph. (Refer to wiring diagram in Figs. 11-1 and 11-2.)

When the car owner shuts the wiper "off" at the dash switch, the motor circuit to ground is opened at the dash. However, the parking switch contacts, which are normally closed, maintain the motor circuit to ground at the wiper. This allows the wiper to keep operating until the blades or wiper crank arm can reach the park position (Blades approx. 2" above windshield molding). At the same time the blades reach the park position, a cam on the output gear opens the park switch contacts. This opens the motor circuit to ground, stopping the motor. Thus, the parking switch actually controls wiper operation only during that short period of time, between the owner turning the wiper "off" at the dash switch and when the wiper has completely stopped.

Turning the wiper "on" at the dash switch overrides the open park switch contacts and closes the wiper motor circuit to ground starting the wiper.

*NOTE: Although the park switch contacts are opened once during each revolution of the output gear, the park switch has no control over the wiper until the dash switch is turned "off".*

## CONNECTIONS TO OPERATE WIPER

Fig. 11-86 shows the proper method of connecting jumper leads to the wiper so that it can be operated

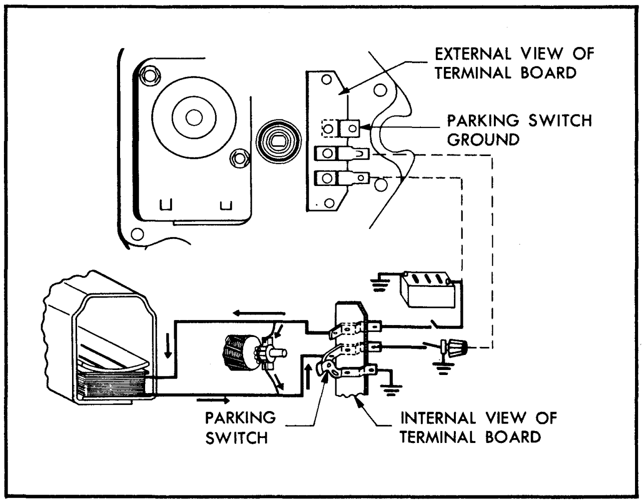



Fig. 11-85 Wiper Wiring Diagram

independently of the dash switch or car wiring for test purposes.

*NOTE: Specification table at end of this section lists current draw data.*

## WIPER SWITCH—REPLACE (FIG. 11-87)

1. Loosen Allen screw and remove knob.

2. Remove retaining nut securing shaft and escutcheon.

3. Remove switch and disconnect terminal.

4. To install, reverse above procedure.

## WIPER TRANSMISSIONS AND LINKAGE—REPLACE (FIG. 11-88)

1. Remove arm and blade assemblies.

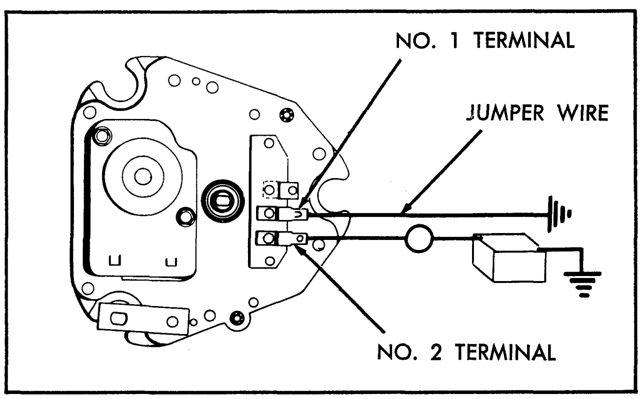



Fig. 11-86 Connection for Test Purposes

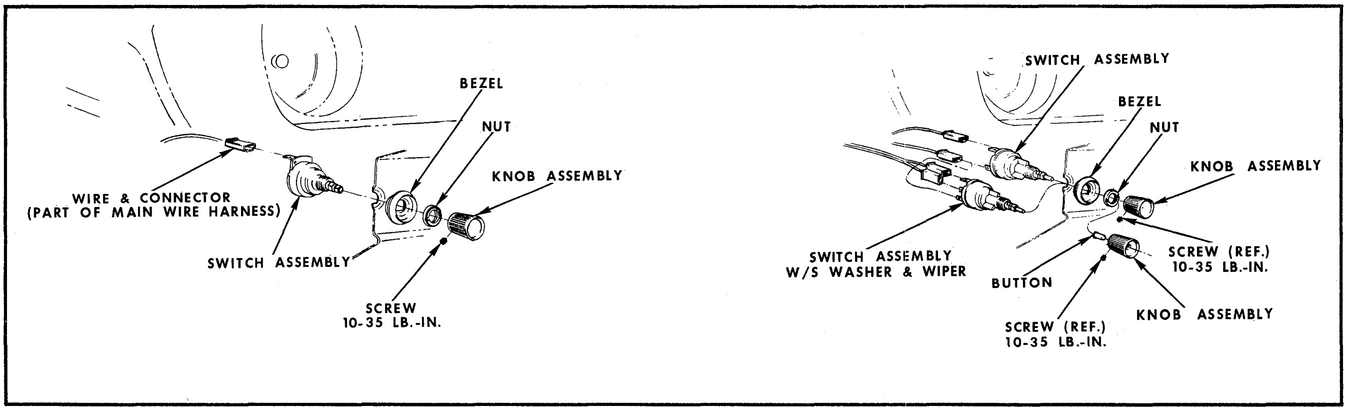



Fig. 11-87 Windshield Wiper Switch

2. Remove fresh air intake grille.

3. Remove wiper transmission retaining screws.

4. Remove retainer securing right wiper transmission crank to linkage which attaches to wiper motor crank.

5. Remove wiper transmissions and linkage.

6. To install, reverse above procedure. Make sure wiper blades are in park position after they are installed.

## REMOVE WIPER

1. Remove wire terminals connected to wiper unit.

2. Remove retainer securing wiper crank to wiper transmission arm. This connects inside the car at fire wall, under instrument panel.

3. Remove screws securing wiper assembly to fire wall.

## INSTALL WIPER

1. Make sure gasket is on motor (Fig. 11-88).

2. Install wiper assembly on fire wall and secure.

3. Connect wire terminals.

4. Connect wiper crank to wiper transmission arm.

## TROUBLE DIAGNOSIS

Trouble diagnosis procedures are divided into two categories: (1) Wiper installed in car; (2) Wiper detached from car.

Typical Trouble Conditions

A. Inoperative

B. Will not shut off

C. Intermittent operation

D. Blades do not return to park position when wiper is turned off.

### *WIPER INSTALLED IN CAR*

WIPER INOPERATIVE—Important: Ignition switch must be on to make electrical tests.

1. Check the following:

(1) Car wiring harness is properly attached to wiper terminals and dash switch.

(2) Wiper ground strap properly connected to wiper and car body.

(3) Dash switch is mounted securely in dash.

(4) Check fuse.

2. If everything checks out in step 1 and wiper fails to operate, disconnect wiring harness from wiper and check for 12 volts at harness terminal that connects to wiper terminal No. 2, Fig. 11-86.

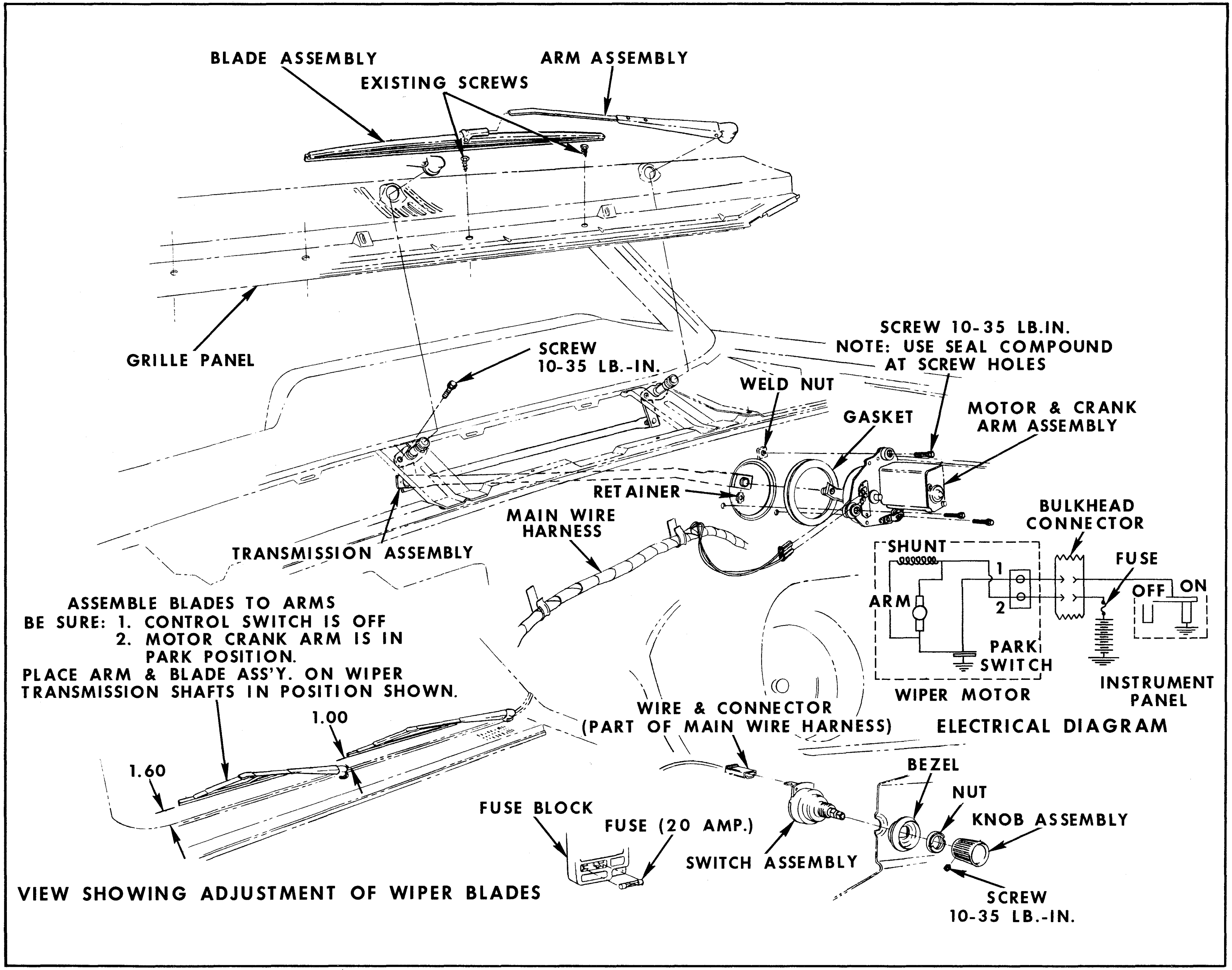



Fig. 11-88 Windshield Wiper (Single Speed) Installation

No voltage indicates defective car wiring.

*CAUTION: Do not connect hot line to No. 1 Terminal.*

3. Connect 12 volt supply to No. 2 wiper terminal and connect a jumper wire from terminal No. 1 to ground (Fig. 11-86). If wiper operates, the dash switch or wiring between dash switch and wiper is defective.

4. If wiper fails to operate in step 3 remove body parts as required to disconnect wiper transmission from wiper crank arm. Recheck wiper operation as explained in step 3. If wiper operates correctly, a defective transmission or binding condition exists. If wiper still fails to operate, remove wiper from car and follow instructions under "Wiper Detached From Car."

WIPER WILL NOT SHUT OFF

1. Disconnect wiring from dash switch. If wiper shuts off, a defective dash switch is indicated.

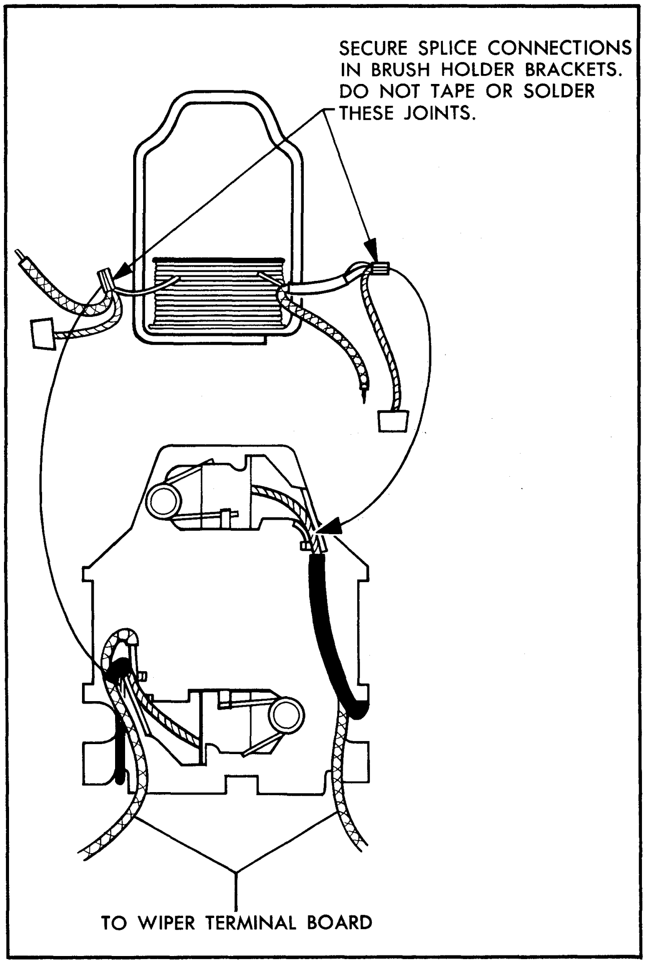



Fig. 11-89 Motor Splice Connections

2. If wiper still operates in step 1, disconnect wiring from wiper and connect 12 volt supply direct to wiper terminal No. 2 (Fig. 11-86). Do not connect any jumper wire to terminal No. 1.

- Wiper shuts off correctly - check for grounded lead that extends between wiper terminal No. 1 and dash switch.

- Wiper fails to shut off - remove wiper from car and follow instructions under "Wiper Detached From Car."

INTERMITTENT OPERATION

1. Check the following: Loose ground strap, loose dash switch mounting, loose connection.

DO NOT RETURN TO PARK POSITION WHEN WIPER IS TURNED OFF

Remove wiper from car and check for a dirty or broken park switch (See Fig. 11-83 for park switch location).

***WIPER DETACHED FROM CAR***

Connect 12 VDC Power source and ammeter to wiper as shown in Fig. 11-86 and observe current draw and wiper operation.

NOTE: Identify wiper part number from wiper motor end cap and select proper current draw from specification table.

WIPER INOPERATIVE

- Current Draw-0

1. Check solder connection at terminal board.

2. Disassemble motor section and check all splice connections (Fig. 11-89).

- Current Draw-2-3 amps

Disassemble motor and check for the following items:

a. Open armature.

b. Brushes sticking.

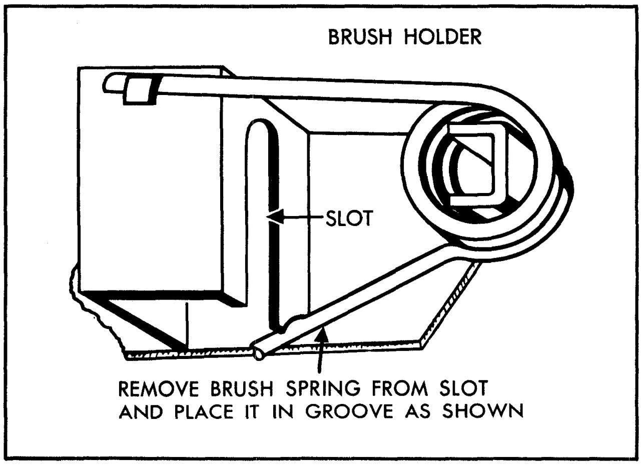



Fig. 11-90 Brush Spring

c. Brush springs improperly positioned (See Fig. 11-90).

d. Brush pigtail connections at splice joints (Fig. 11-89).

- Current Draw-10-12 amps

1. Check for open shunt field circuit.

2. Check for broken gear.

WIPER RUNS SLOW, VIBRATES AND CURRENT DRAW APPROX. 7-9 AMPS

1. Check for binds in gear train.

2. Check for shorted armature (armature may be checked on a growler).

WIPER SHUTS OFF BEFORE CRANK ARM REACHES PARK POSITION

Wiper crank arm stops rotating immediately when jumper wire is disconnected from wiper terminal No. 1 (Fig. 1-86).

*NOTE: When crank arm has reached park position the crank arm index grooves will line up approx. with the ridges on the gear box cover (Fig. 11-91).*

Check for dirty, broken or bent park switch contacts.

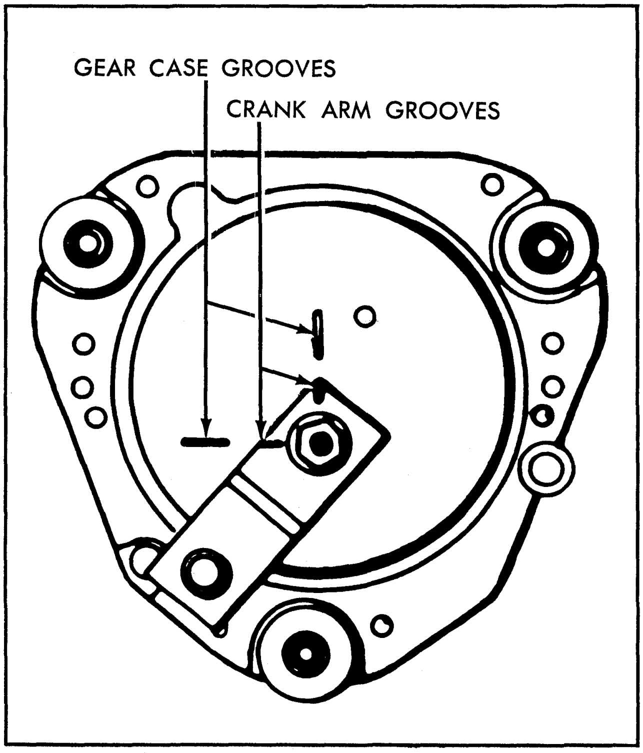



Fig. 11-91 Crank Arm in Park Position

WIPER WILL NOT SHUT OFF

Wiper crank arm fails to stop in park position when jumper wire is removed from wiper Terminal No. 1, Fig. 11-86.

1. Check that park switch contacts are opening.

2. Check for grounded condition in the internal motor lead that connects to terminal No. 1, Fig. 11-86.

## ADJUSTMENTS

Armature end play is automatically adjusted by the proper assembly of end play washers. See Fig. 11-93 for proper assembly of end play washers.

## GEAR BOX

### *DISASSEMBLE*

1. Clamp crank arm in a vise and remove crank arm retaining nut, arm, retainer ring, and endplay washers.

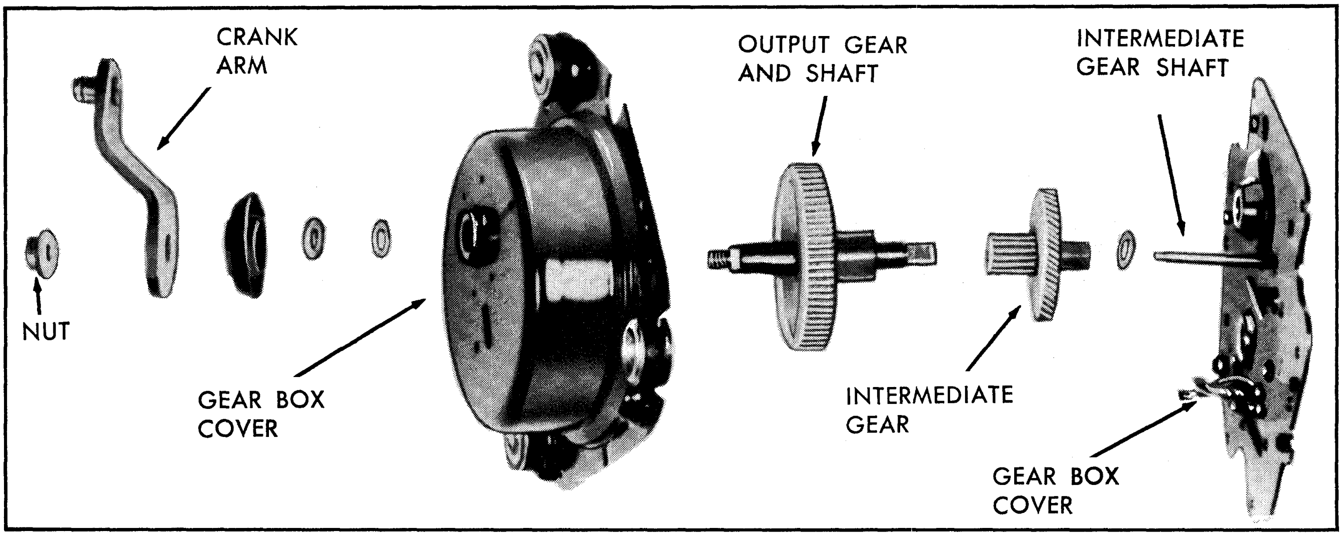



Fig. 11-92 Gear Box - Exploded View

2. Drill out the gear box cover retaining rivets and remove cover from gear train.

*CAUTION: Mark ground strap location for reassembly purposes.*

*NOTE: Screws, nuts and lockwashers for reassembling cover to wiper are contained in a service repair package.*

3. Remove output gear and shaft assembly, then slide intermediate gear and pinion assembly off shaft. (Fig. 11-92).

4. Remove terminal board and park switch assembly as follows:

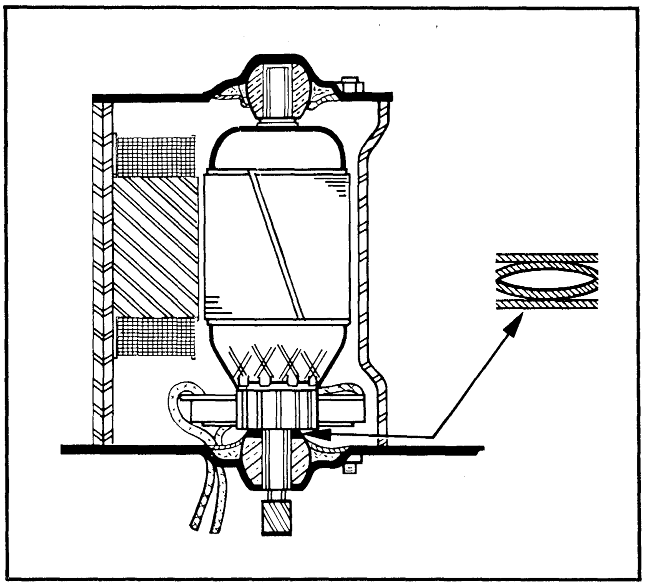


Fig. 11-93 End Play Washers

a. Unsolder motor leads from terminals.

b. Drill out rivets that secure terminal board and park switch ground strap to plate.

*NOTE: Screws, nuts and washers for attaching a replacement terminal board-park switch assembly are included with the replacement assembly.*

ASSEMBLY

Reverse steps 1 thru 4 except as noted:

1. Reassembly of Gear Cover - Be sure cover is located properly over locating dowel pins and be sure to re-install ground strap and gasket.

2. Reassembly of Crank Arm - Operate wiper to park position (Fig. 11-86) and install crank arm on output shaft so that identification marks line up with those in the cover (Fig. 11-91). Clamp crank in vise before securing the retaining nut.

## MOTOR SECTION

### *DISASSEMBLE AND ASSEMBLE*

Refer to Fig. 11-94.

1. Follow steps 1 thru 4 (a) under gear box disassembly.

2. Remove tie bolts.

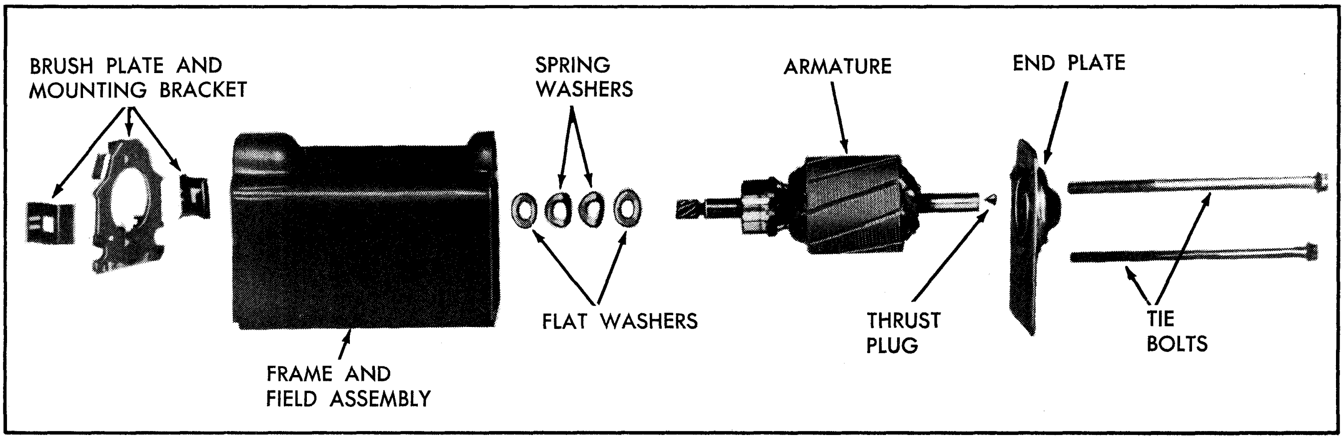



Fig. 11-94 Motor - Exploded View

3. Release brush spring pressure against brushes as shown in Fig. 11-90.

4. Move brushes away from armature and slide armature out of frame and field assembly. Pull end cap assembly off armature.

5. Remove end play adjusting washers.

To reassemble motor, reverse steps 1 thru 4 as required.

## LUBRICATION

Armature shafts and Bearings:

Light Grade Machine Oil

Gear Teeth (All):

Delco Cam and Ball Bearing Lubricant.

## WIPER SPECIFICATIONS

- Operating Test Voltage . . . . . . . . . 12 VDC
- Crank Arm Rotation (looking at arm) . . CCW
- Crank Arm Speed . . . . . . . . . . . . 43 RPM
- Current Draw (Amps.)
  - No load . . . . . . . . . . . . . . . . . . 3 Max.
  - Dry windshield . . . . . . . . . . . . 3.5 Max.
  - Stall . . . . . . . . . . . . . . . . . 11.0 Max.

# TWO SPEED WIPER

## GENERAL DESCRIPTION

The mounting used for the single speed wiper is used for the 2 speed wiper (Fig. 11-95).

## PRINCIPLE OF OPERATION

The principle of operation is very similar to that of the single speed wiper. A combination pictorial and schematic circuit is shown in Fig. 11-96. An explanation of "LO," "HI" and parking circuits follows:

***LO SPEED (Fig. 11-97)***

When the dash switch is moved to the "LO" speed position (Ign. Sw. On) current from the battery flows through the series field coil and divides; part passing through the shunt field coil to ground at the dash switch, the other part passing through the armature to ground at the dash switch.

***HI SPEED (Fig. 11-98)***

Moving the "Dash" switch to the "HI" speed position opens the shunt field circuit to ground at the dash switch and keeps the armature circuit closed to ground. The shunt field current must then pass through a 24 ohm resistor located on the back of the wiper terminal board, and then through the same lead that connects the armature circuit to ground through the dash switch.

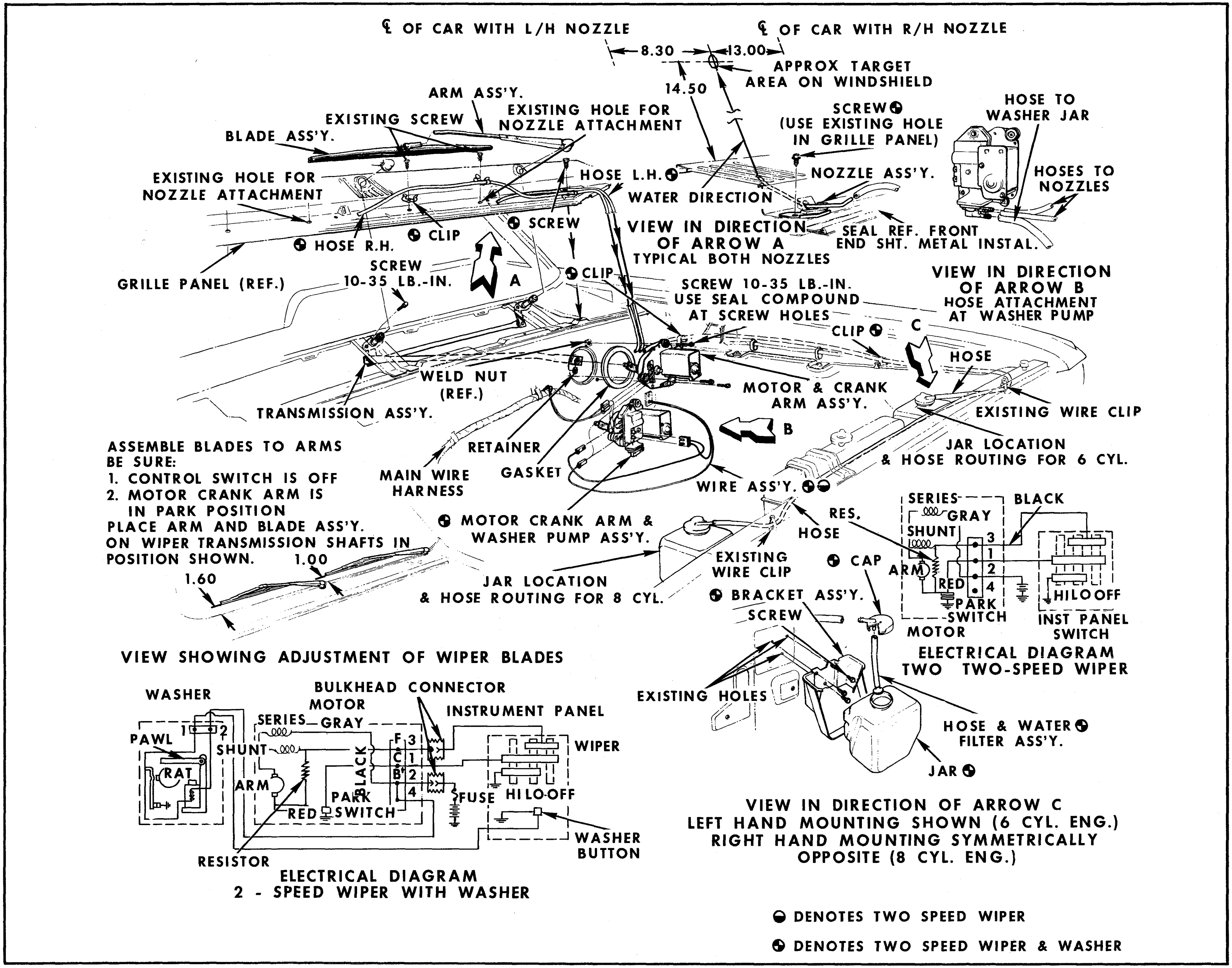



Fig. 11-95 Two Speed and Single Speed Wipers

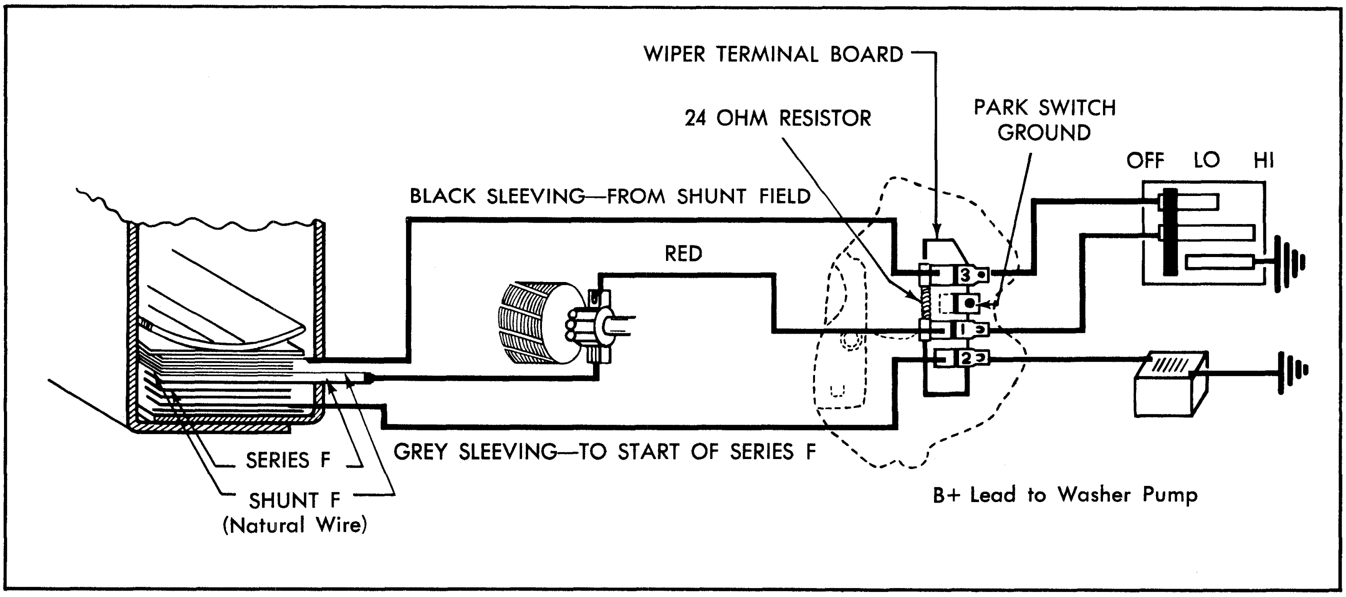



Fig. 11-96 Wiper Wire Schematic

***PARKING CIRCUIT (Fig. 11-99)***

Moving the dash switch to the "off" position opens both the armature and shunt field circuits to ground at the dash switch. However, both of these circuits are still closed to ground through the parking switch.

*NOTE: The shunt field circuit actually flows via the dash switch back to the wiper parking switch direct to ground which means that wiper is actually operating in "LO" speed during the parking cycle.*

When the cam on the wiper output gear opens the park switch contacts, the wiper is "off" and the blades and/or wiper crank arm should be in the park position.

## CONNECTIONS TO OPERATE WIPER

Fig. 11-100 illustrates the method of connecting leads to the wiper for either bench operation or to run wiper independently of dash switch and car wiring when installed in car.

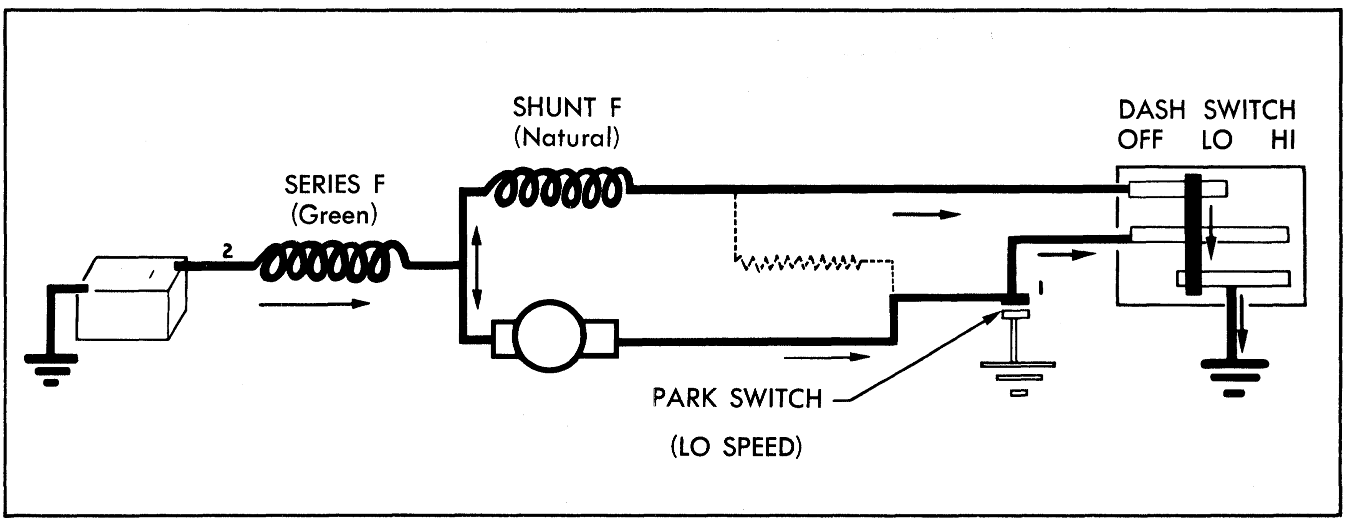



Fig. 11-97 Low Speed Circuit

## TROUBLE DIAGNOSIS

Typical Wiper Troubles:

A. Wiper inoperative.

B. Wiper will not shut off.

C. Wiper has one speed fast.

D. Wiper has one speed slow and shuts off with Dash Switch in "Hi" speed position.

E. Blades do not return to park position when wiper is turned "off."

F. Wiper speed normal in "Lo" but too fast in "Hi."

G. Intermittent operation.

Trouble diagnosis procedures are divided into two (2) main categories:

(1) Wiper Installed In Car.

(2) Wiper Detached From Car.

### *WIPER INSTALLED IN CAR*

WIPER INOPERATIVE

1. Check that wiring harness is properly connected to wiper and dash switch; wiper ground strap is connected securely to car body; and dash switch is securely mounted.

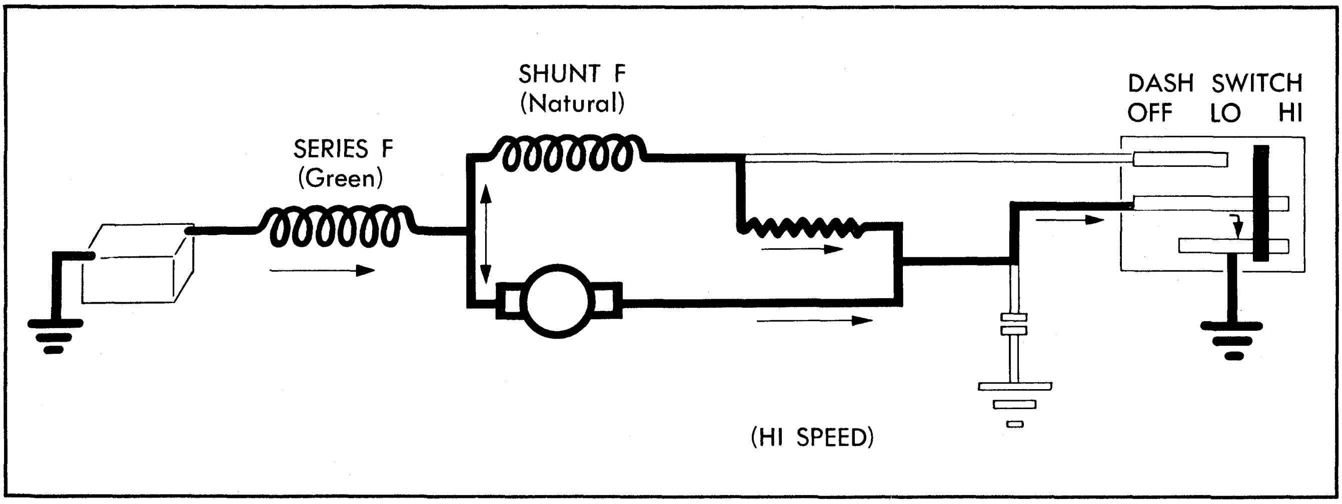



Fig. 11-98 Hi Speed Circuit

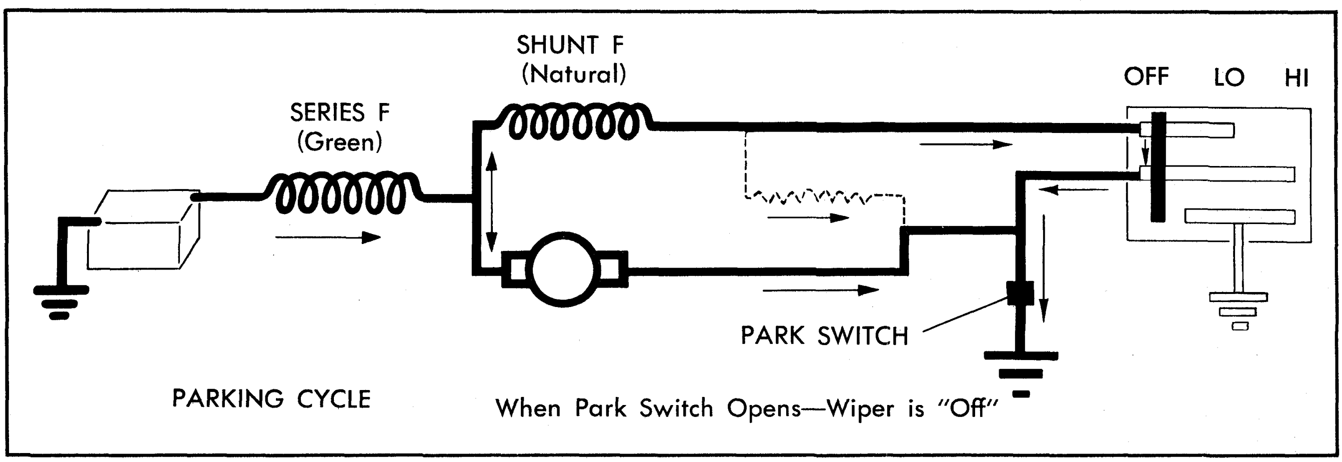



Fig. 11-99 Parking Cycle

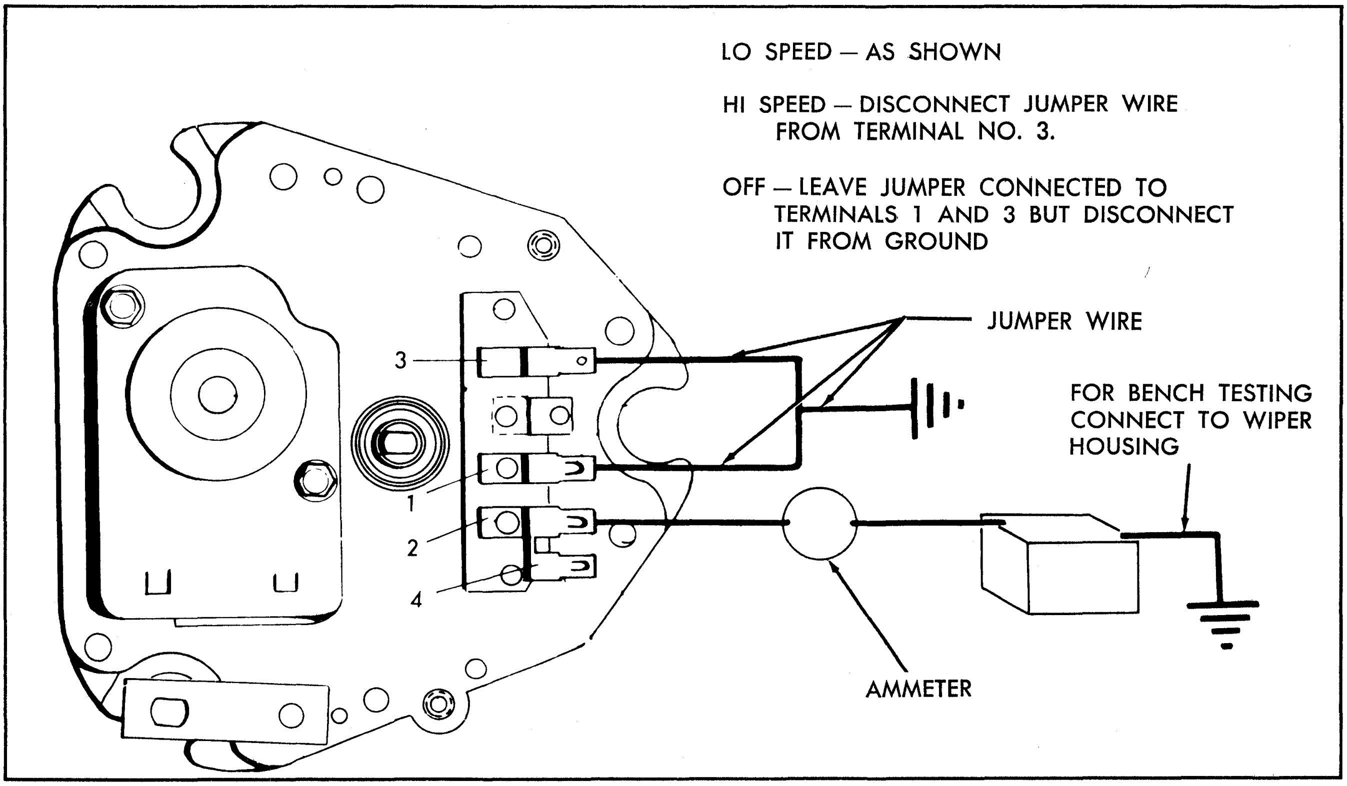



Fig. 11-100 Connections for Testing

2. With ignition switch on, check for 12 volts at harness terminal that connects to number (2) terminal (Fig. 11-100).

3. To determine if dash switch or car wiring are at fault, disconnect harness from wiper motor and try operating wiper as shown in Fig. 11-100. If wiper fails to operate, remove body parts as required, disconnect transmissions from wiper crank arm and recheck wiper operation. If wiper still fails to perform correctly, remove wiper from car and check wiper according to procedure under "Wiper Detached From Car."

WIPER WILL NOT SHUT OFF

1. Determine if wiper has both "Lo" and "Hi" speeds, "Lo" speed only, or "Hi" speed only.

*NOTE: Wiper must operate in "LO" speed during parking cycle.*

2. Disconnect wiring harness from wiper motor and try operating wiper independently of dash switch as shown in Fig. 11-100.

- If wiper operates correctly independently of the dash switch, (i.e. shuts off correctly with crank arm in park position) refer to the table below for possible trouble location -

| Step 1 Diagnosis | Possible Trouble |
|---|---|
| Wiper had both speeds | (1) Lead between wiper terminal No. 1 and dash switch grounded.<br>(2) Defective dash switch. |
| Wiper had "Lo" speed only | (1) Lead between wiper terminal No. 3 and dash switch grounded.<br>(2) Defective dash switch. |
| Wiper had "Hi" speed only | (1) Lead between wiper terminal and dash switch open.<br>(2) Defective dash switch. |

- If wiper still fails to operate correctly in step 2, remove it from car and check it per instructions under "Wiper Detached From Car."

WIPER HAS ONE SPEED-FAST

Check for a defective dash switch or open lead between terminal Number 3 and dash switch.

WIPER HAS ONE SPEED SLOW AND SHUTS "OFF" WITH DASH SWITCH IN "HI" SPEED POSITION

Reverse harness leads that connect to wiper terminals 1 and 3.

BLADES DO NOT RETURN TO PARK POSITION WHEN WIPER IS TURNED "OFF"

1. Check wiper ground strap connection to car body.

2. Remove wiper from car and check for dirty, bent or broken park switch contacts.

WIPER SPEED NORMAL IN "LO" BUT TOO FAST IN "HI"

Remove wiper from car and check for an open terminal board resistor.

INTERMITTENT OPERATION

Check for loose wiper ground strap connections and/or loose dash switch mounting.

### *WIPER DETACHED FROM CAR*

It is assumed that in many cases there is no information available to the repairman about the original wiper complaint. It is necessary, therefore, that wiper operation be checked according to the instructions shown in Fig. 11-100.

*NOTE: Be sure and use an ammeter capable of reading at least 30 amperes in the feed wire circuit.*

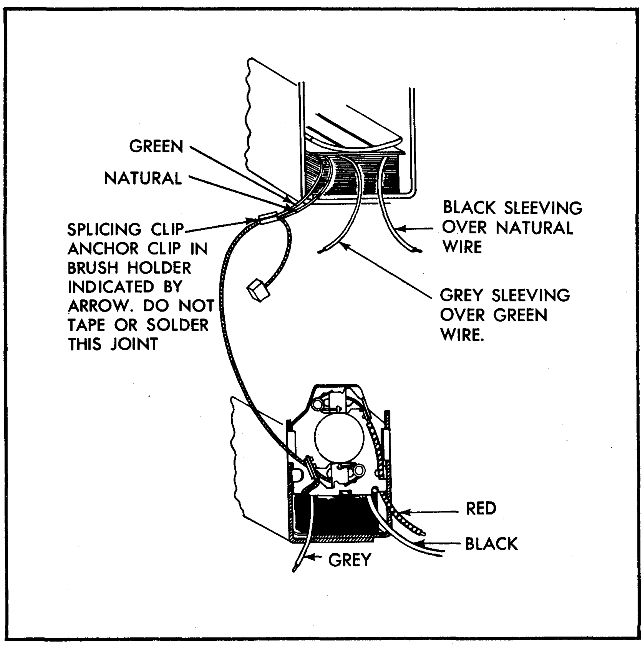



Fig. 11-101 Internal Wiring

WIPER INOPERATIVE

Connect up wiper to operate in "Lo" speed and observe current draw. Current draw ratings shown below will provide a hint as to the possible source of trouble.

| Ammeter Reading (Amps) | Possible Trouble |
|---|---|
| 0 | (1) Loose solder connection at wiper terminal No. 2.<br>(2) Loose splice joints (Fig. 11-101). |
| 1-1.5 | (1) Open armature.<br>(2) Brushes sticking.<br>(3) Loose splice joint. |
| 11.0 | (1) Broken gear or some other condition that will stall the wiper. |

WIPER WILL NOT SHUT OFF AND,

| | Possible Trouble—Refer |
|---|---|
| Wiper has both speeds | (1) Park switch contacts not opening.<br>(2) Internal wiper motor lead that connects to wiper terminal No. 1 grounded. |
| Wiper has "Lo" speed only | (1) Internal wiper motor lead that connects to wiper terminal No. 3 grounded.<br>(2) Shunt field coil grounded. |
| Wiper has "Hi" speed only | (1) Internal wiper motor lead that connects to wiper terminal No. 3 open.<br>(2) Shunt field open. |

WIPER HAD "HI" SPEED ONLY—See Typical Trouble in table above.

WIPER HAS "LO" SPEED ONLY—See Typical Trouble in table above.

WIPER CRANK ARM DOES NOT RETURN TO PARK POSITION when wiper is turned off (i.e. crank arm stops rotating immediately).

Check for dirty, bent or broken park switch contacts.

WIPER SPEED NORMAL IN "LO" BUT TOO FAST IN "HI"

Check for open 24 ohm resistor on back of wiper terminal board.

INTERMITTENT OPERATION

Check for sticking brushes, loose splice joints, etc.

## DISASSEMBLY-ASSEMBLY PROCEDURES

Except for the internal wiring to the wiper terminal board, the disassembly-assembly procedures for the two speed wiper covered in this section are the same as those outlined for the single speed wiper. See Fig. 11-101 for internal wiring.

## WIPER SPECIFICATIONS

| | |
|---|---|
| Operating Volts | 12 VDC |
| Crank Arm Rotation (looking at Crank Arm) | Counterclockwise |
| Crank Arm Speed (RPM's) (No Load): | |
| Lo | 34 Min. |
| Hi | 65 Min. |
| Current Draw—Amps.: | |
| No Load (Lo Speed) | 3.6 Max. |
| Installed in Car—(Dry Glass) | 4.5 Max. |
| Stall | 12 Max. |
| Shunt Field Resistance | |

# WINDSHIELD WASHER PUMP

## PRINCIPLE OF OPERATION

The pump is a positive displacement type, employing a small bellows, bellows spring and valve arrangement. The pumping mechanism is actuated by a pin driven by the wiper. The programming (starting and completion of a wash cycle) is accomplished electrically and mechanically by a relay assembly and ratchet wheel arrangement. (See Fig. 11-102).

Explanation of pump operation follows:

### *WIPER ON—WASHER OFF*

- When the washer pump is mounted on the wiper correctly, a pin on the lower side of the pump engages with a 4 lobe cam (Fig. 11-103). The pin is part of a spring loaded plate and ratchet pawl assembly and acts as a cam follower. Thus, with the wiper running, the pin actuates the plate and ratchet pawl assembly back and forth in a horizontal plane. Another pin, attached to the upper side of the plate and ratchet pawl assembly, extends through a slot in the bellows plunger arm. This pin moves freely back and forth in the slot while the pumping mechanism is in the "lock-out" position and no pumping action occurs.

The pump is in the "lock-out" position when the relay holding contacts are open and a tang on the plunger arm rests against the widest part of an eccentric ramp located on the lower surface of the ratchet wheel (Fig. 11-104). The tang holds the bellows plunger arm in a retracted position (bellows spring compressed) allowing the plunger arm actuator pin on the plate and ratchet pawl assembly (Fig. 11-102) to move freely back and forth in the plunger arm slot and thus no pumping action occurs.

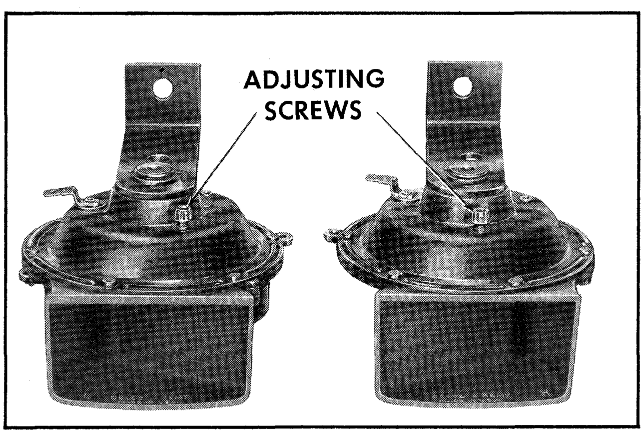



Fig. 11-102 Washer Pump Assembly

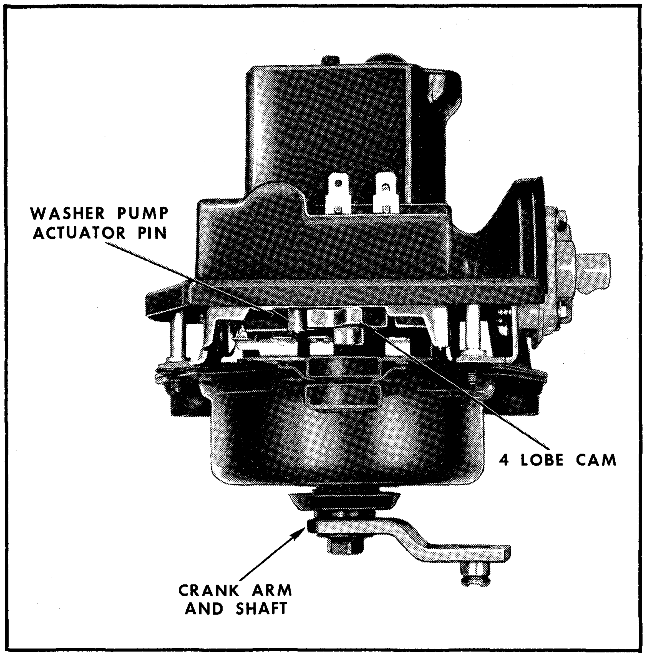



Fig. 11-103 Washer Pump Drive System

The ratchet pawl is spring loaded to hold it away from engaging the ratchet wheel teeth until such time as the washer pump relay is energized by the dash switch washer button.

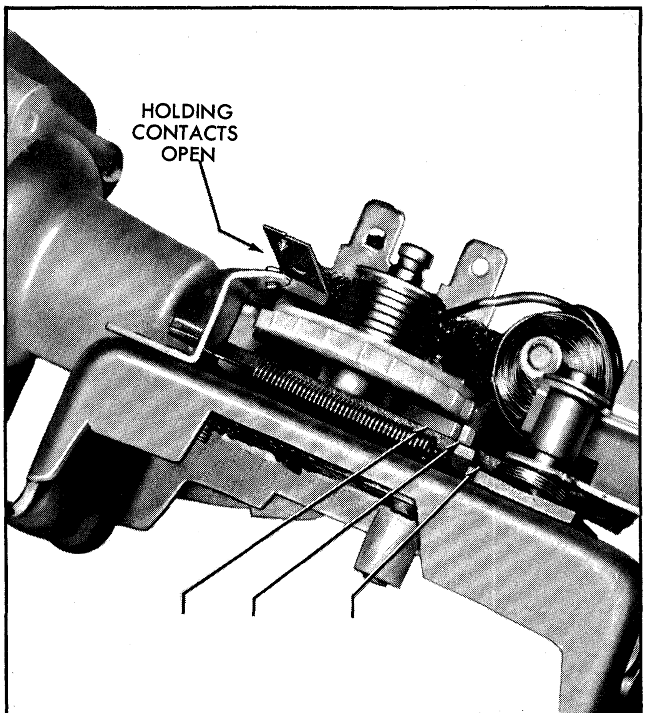



Fig. 11-104 Washer Pump Assembly

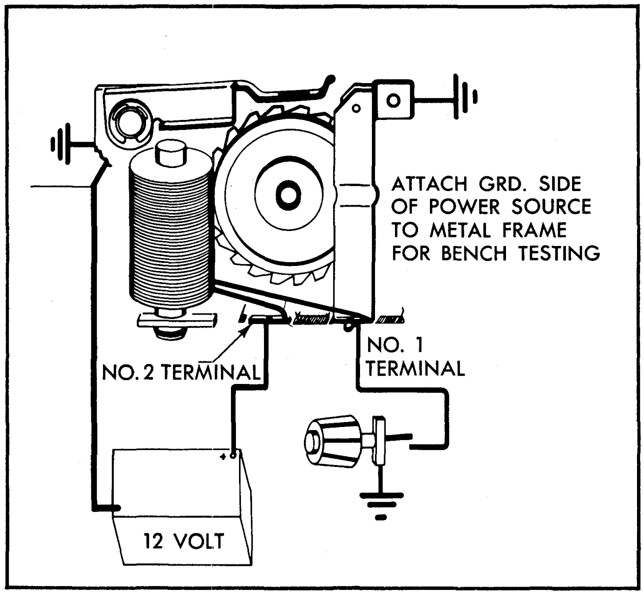



Fig. 11-105 Pump Wiring Circuit

### *TURNING THE WASHER ON*

Depressing the dash switch washer button closes the washer pump relay circuit to ground. (Refer to Fig. 11-105).

*NOTE: If wiper was "off" the wiper switch is mechanically turned on to the "On" position by the washer button.*

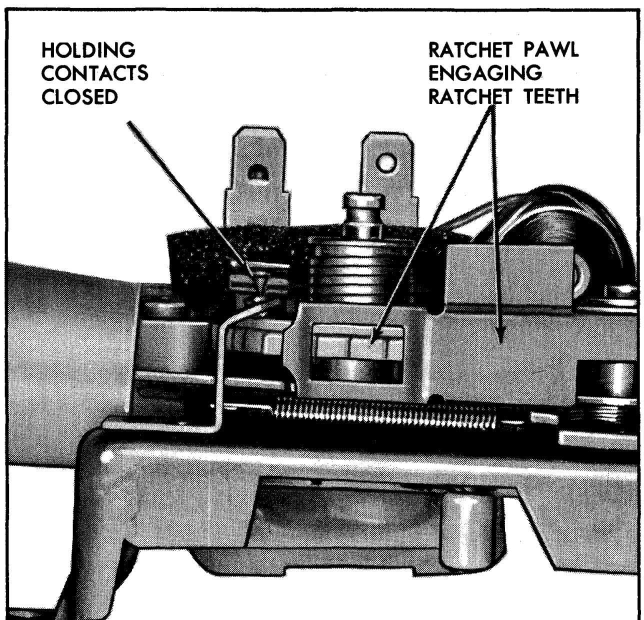



Fig. 11-106 Pump Contacts and Racket Pawl

With the washer relay coil energized, the ratchet pawl, which is normally held away from the ratchet wheel by a spring, is pulled toward the coil pole and engages the ratchet wheel teeth. The ratchet pawl and plate assembly, which moves back and forth continuously when the wiper is on, now starts to rotate the ratchet wheel (Fig. 11-106).

When the ratchet wheel has been rotated one tooth, two simultaneous functions occur (1) the eccentric ramp on the ratchet wheel is moved away from the plunger arm tang, releasing the pumping mechanism from its "lock-out" position and (2) a set of holding contacts close, maintaining the coil circuit to ground. The contacts will stay closed until the ratchet wheel has been turned through 360° or 21 teeth, at which time the ratchet wheel will again open the contacts.

### *PUMPING CYCLE*

(EXHAUST HALF OF PUMP STROKE):

With the pumping mechanism released from its "lock-out" position, the bellows spring expands and collapses the bellows forcing water out two outlet valves (Fig. 11-107). The plunger arm, which is attached to the bellows, is pulled forward with the bellows and the back edge of the plunger arm slot moves up tight against the plunger arm actuator pin. (Refer to Fig. 11-102 to identify plunger arm slot and pin.) The actuator pin, which was previously moving back and forth freely in the plunger arm slot, will now pull the plunger arm back and compress the bellows spring each time the pin actuates the plate and ratchet pawl assembly.

(INTAKE HALF OF PUMP STROKE):

Pulling the plunger arm back compress the bellows spring (Fig. 11-108) and water is drawn into the

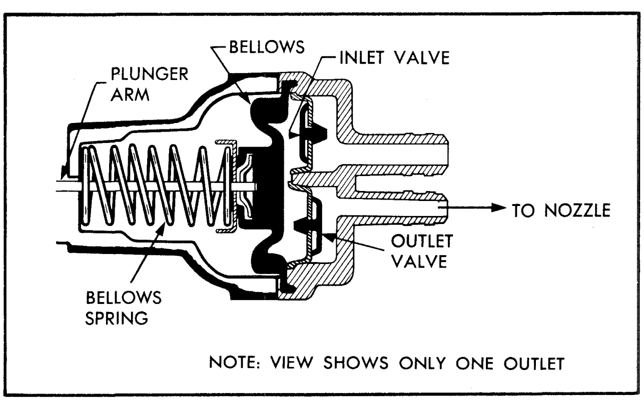



Fig. 11-107 Pumping Cycle (Exhaust)

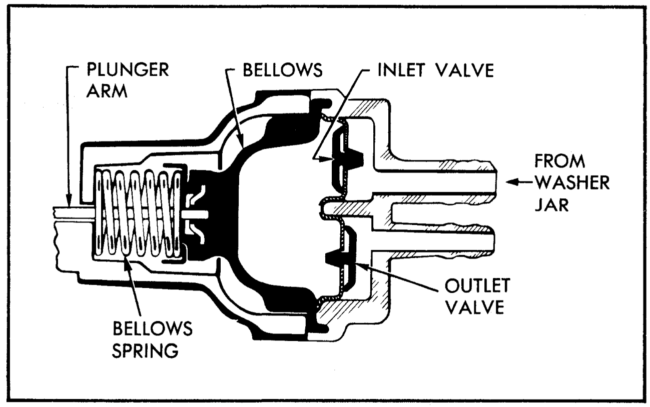



Fig. 11-108 Pumping Cycle (Intake)

bellows through the intake valve. During the intake of water, the exhaust or outlet valves are drawn tight against their seats. During each intake stroke of the pumping mechanism, the ratchet wheel is rotated one tooth.

### *COMPLETION OF WASH CYCLE*

The wash cycle is completed when the electrical circuit to the relay coil is opened and the pumping mechanism reaches its "lock-out" position. This is accomplished as follows:

When the ratchet wheel has been rotated through 360° or 21 teeth, the relay coil holding contacts are pushed open by a "hump" on the ratchet wheel. This opens the coil circuit and the spring loaded ratchet pawl moves away from the ratchet wheel preventing further rotation of the ratchet wheel.

As the ratchet wheel rotates the tang on the bellows plunger arm starts to ride up the eccentric ramp on the lower surface of the ratchet wheel. The full "lock-out" position of the pumping mechanism is reached when the tang is up on the widest part of the ramp (Fig. 11-104). The tang reaches the "lock-out" position at the same time the relay coil holding contacts open.

## TROUBLE DIAGNOSIS

Trouble shooting procedures are divided into two categories (1) Washer installed in car and (2) Washer detached.

### WASHER PUMP ON CAR

WASHER INOPERATIVE:

1. Check the following items:

(1) Jar has adequate quantity of water solution.

(2) Hoses are not damaged and hose connections are tight.

(3) Screen at end of jar cover hose is not plugged.

(4) Electrical connections to washer pump and dash switch.

(5) Nozzles are not plugged.

2. If all items in step 1 check out, start wiper motor only, then push washer button and listen for "click" as washer relay pulls in. If no "click" is heard, check for 12 volts at terminal No. 2 (Fig. 11-109). No voltage indicates defective wiring. If "click" is heard, proceed to step 4.

3. If correct voltage was found in step No. 2, connect a jumper wire from terminal No. 1 to ground (Fig. 11-109) and operate wiper. If washer relay "click" is heard and pump functions correctly, a defective dash switch or an open circuit between washer pump and dash switch is indicated - "No Click" indicates an open relay coil.

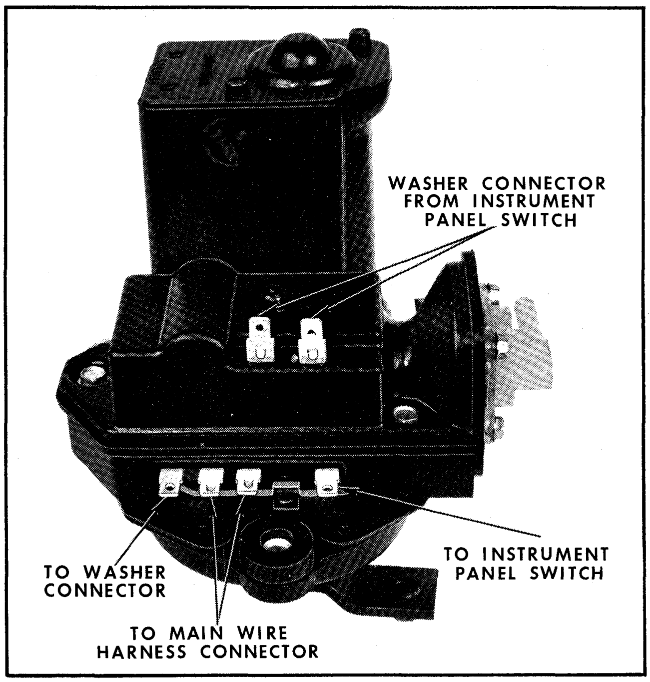



Fig. 11-109 Washer Pump Terminals

4. If relay "click" is heard in step 2, listen for the soft clicking as the pump ratchet wheel is rotated. - If "soft clicking" is not heard, the pump mechanism is faulty and should be removed from the wiper motor and checked.

- If soft clicking is heard but no pumping action occurs, replace the valve assembly and recheck pump.

### WASHER PUMP DETACHED

CHECK PUMP OPERATION AS FOLLOWS:

1. Remove washer pump cover and connect 12 volt power supply to washer pump as shown in Fig. 11-105 Connect jumper wire from terminal No. 1 to ground. Turn ratchet pawl to the position shown in Fig. 11-105. Ratchet pawl should be pulled toward relay pole and engage ratchet teeth. Failure to do as described above indicates an open relay coil.

2. If relay and ratchet pawl perform correctly in step 1, manually actuate the plate and ratchet pawl assembly to turn the ratchet wheel one tooth. Observe if relay holding contacts close (Fig. 11-106) and the pump plunger arm is released from its "lock-out" position. (Fig. 11-104 shows plunger arm in "lock-out" position.)

3. Disconnect jumper wire from terminal No. 1. Relay coil should remain energized and hold ratchet pawl against ratchet wheel. Failure to do so indicates open or dirty holding contacts.

4. If pump performs correctly in step 3, continue to manually actuate the plate and ratchet pawl assembly until the ratchet wheel has been turned through 360° or 21 teeth. After the ratchet wheel has been rotated 21 teeth, the holding contacts should be opened by a "hump" on the wheel and the pump plunger arm should be in the "lock-out" position (Fig. 11-104).

CHECK VALVE ASSEMBLY AS FOLLOWS:

1. Attach a hose to the large or intake pipe. You should be able to blow through it but not draw through it.

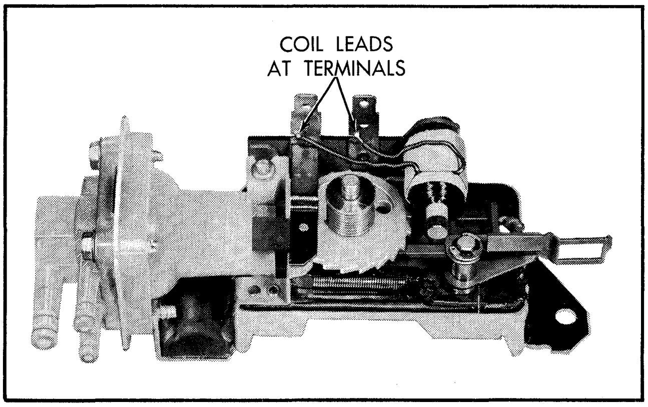



Fig. 11-110 Coil Leads at Terminals

2. Attach a hose individually to each of the small or exhaust pipes. You should be able to draw through them but not blow through them.

If any of three valves allow air to pass in both directions, the valve assembly is defective.

## DISASSEMBLY PROCEDURES

### RELAY COIL (Figs. 11-110, 11-111)

1. Remove washer pump cover.

2. Unsolder coil leads from terminals.

*NOTE: No coil polarity is necessary when re-soldering coil leads.*

3. Pry off coil retainer clip and slip coil assembly out of mounting bracket.

*NOTE: A new clip is supplied with replacement coils.*

### RATCHET PAWL

1. Remove washer pump cover.

2. Disengage spring from ratchet pawl.

*CAUTION: Be sure spring is properly assembled before replacing washer pump cover.*

3. Squeeze the slotted nylon ratchet pawl post together and slide ratchet pawl of the post.

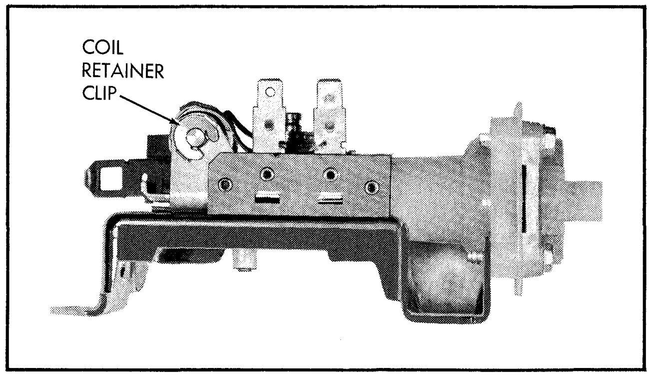



Fig. 11-111 Coil Retainer Clip

### VALVE ASSEMBLY (Fig. 11-112)

Remove the four screws that secure the nozzle assembly to the bellows housing (Fig. 11-112).

*CAUTION: It is sometimes necessary to carefully pry the bellows lip out of the valve body groove.*

### BELLOWS—BELLOWS SPRING

1. Remove valve assembly (Fig. 11-112).

2. Manually rotate ratchet wheel as required to release pump from "lock-out" position. "Lock-out" position shown in Fig. 11-113 - plunger arm tang against ratchet wheel ramp.

3. Hold end of plunger arm (Fig. 11-113) from moving. At the same time, push in against bottom of bellows with thumb and turn bellows 90°. This should release bellows.

4. Slide bellows spring and spring retainer off plunger arm.

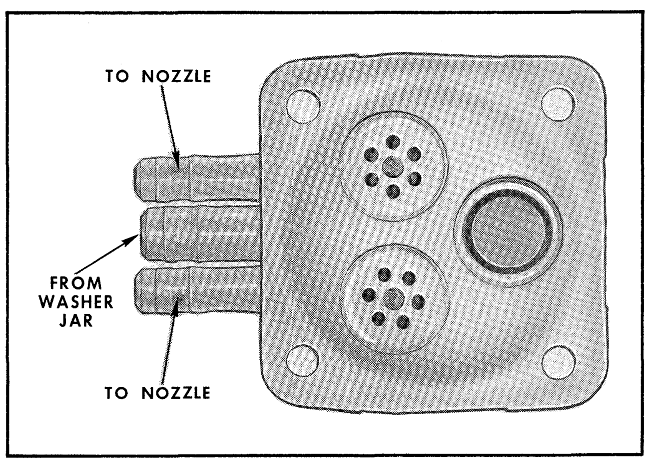



Fig. 11-112 Valve Assembly

5. To replace, reverse above procedure.

## ASSEMBLY PROCEDURES

In each of above cases, reverse procedure to assemble.

## SPECIFICATIONS

| | |
|---|---|
| Number of "squirts" at full pressure | 12 |
| Pressure (PSI) | 11-15 |
| Coil Resistance (ohms) | 20 |

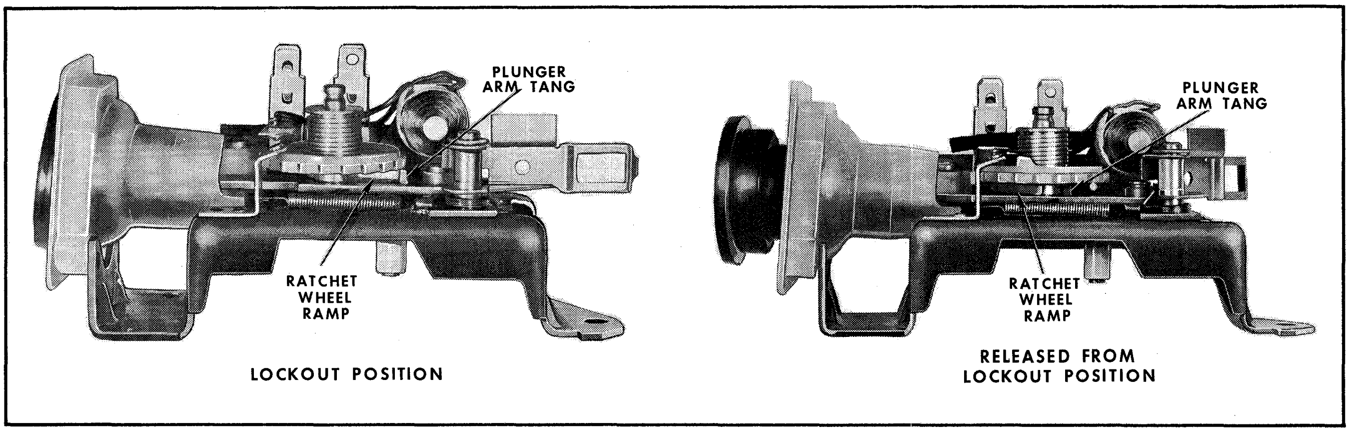



Fig. 11-113 Pump in "Lock Out" Position

## SPECIFICATIONS

| | L-6 Engine 37 Amp Generator | V-8 Engine 37 or 55 Amp Generator | V-8 Engine 22 Series Le Mans 42 Amp Generator |
|---|---|---|---|
| Battery Model | 554 | 458 | 558 |
| Capacity at 20 hr. rate, amp.-hr. | 44 | 53 | 61 |

| | 6 Cylinder Engine Standard | 6 Cylinder Engine Air Condition | V-8 Engine Standard | V-8 Engine Air Condition | V-8 (Transistor Ign.) |
|---|---|---|---|---|---|
| Generator Model | 1100668 | 1100665 | 1100683 S.S. | 1100627 | 1100674 |
| Rated Output | 37 amps, 14 V | 55 amps, 14 V | 37 amps. 14 V | 55 amps, 14 V | 60 amps, 14 V |
| Cold Output | | | | | |
| Amps @ alternator rpm | 25 @ 2000 | 28 @ 2000 | 25 @ 2000 | 28 @ 2000 | 36 @ 2000 |
| Amps @ alternator rpm | @ 5000 | 40 @ 5000 | 35 @ 5000 | 40 @ 5000 | 57 @ 5000 |
| Field Current Draw | 1.9-2.3 amps | 1.9-2.3 amps | 1.9-2.3 amps | 1.9-2.3 amps | 2.65-2.95 amps |
| Regulator Model | 1119515 | 1119515 | 1119515 | 1119515 | 1116366 with A.C. and transistor ign. only 1119515 used otherwise. |
| Air Gap, inches | .057 | .057 | .057 | .057 | |
| Point Opening, in. | .015 | .015 | .015 | .015 | |
| Normal Range (125°F.), volts | 13.5-14.4 | 13.5-14.4 | 13.5-14.4 | 13.5-14.4 | |

| | 6 Cylinder Engine | V-8 Engine | V-8 Engine (22 Le Mans) |
|---|---|---|---|
| Starting Motor Model | 1107301 S.M. 1107302 Auto. | 1107293 | 1107294 |
| Brush Spring Tension, Oz. | 35 | 35 | 35 |
| Resistance Test (Armature Locked) | | | |
| Volts | 4.3 | 3.5 | 2.0 |
| Amperes | 270-320 | 300-360 | 290-370 |
| Solenoid Switch Model | 1114336 S.M. 1110316 Auto. | 1114334 | |
| Hold-in Winding | 10.5-12.5 Amps., 10 Volts | 10.5-12.5 Amps., 10 Volts | 15.5-17.5 Amps., 10 Volts |
| Both Windings | 42-49 Amps., 10 Volts | 42-49 Amps., 10 Volts | 47-54 Amps., 10 Volts |

| | | | V-8 (Transistor Ign.) |
|---|---|---|---|
| Distributor Model | 1110316 | 1111052 | 1111040 |
| Rotation Viewed From Cap End | CC | CC | |
| Point Opening, inches | .019" (new) .016" (used) | .019" (new) .016" (used) | |
| Breaker Lever Tension | 19-23 oz. | 19-23 oz. | |
| Ignition Pulse Amplifier | | | 1115005 |

| | 6 Cylinder Engine | V-8 Engine |
|---|---|---|
| Cam Angle (Set To Range) . . . | 31°-34° | 28°-32° |
| Condenser Capacity Mfd. . . . | .18-.23 | .18-23 |
| Centrifugal Advance (Distributor) | | |
| Start . . . . . . . . . . . . . . | 0°-3° 480 rpm | 0°-2° 400 rpm |
| Intermediate . . . . . . . . . . | 8 1/2°-10 1/2° 925 rpm | 8 1/2°-10 1/2° 1000 rpm |
| Maximum . . . . . . . . . . | 14°-16° 2300 rpm | 11°-13° 2300 rpm |
| Vacuum Control Model . . . . . | 1116198 | 1116172 |
| Inches of Mercury to start advance . . . . . . . | 5-7 | 8-10 |
| Inches of Mercury for full advance . . . . . . . . | 11-13.5 | 14.75-16.75 |
| Maximum Advance in Distributor Degrees . . . . | 11.5° | 10° |

| | 6 Cylinder Engine | V-8 Engine | V-8 (Transistor Ign.) |
|---|---|---|---|
| Ignition Coil Model | 1115184 | 1115187 | 1115189 |
| Primary Resistance, Ohms (75°F,) . . . . . . . . | 1.45 | 1.81-2.01 | .38-.51 |
| Secondary Resistance, Ohms (75° F.) . . . . . . . | 5600-6900 | 7200-9500 | 8200-12400 |

| | | |
|---|---|---|
| Spark Plugs . . . . . . . . . . . . . . . . | A.C. | A.C. |
| Size . . . . . . . . . . . . . . . . . . . . | 14 MM | 14 MM |
| Type . . . . . . . . . . . . . . . . . . . . | 46N | 45S |
| Gap . . . . . . . . . . . . . . . . . . . . | .035" | .035" |
| Torque . . . . . . . . . . . . . . . . . . | 15-25 lb. ft. | 15-25 lb. ft. |
| Ignition Resistor Wire | | |
| Resistance at 80°F. Ohms . . . . . . . | 1.80 | 1.32 |
| Ignition timing (at hot idle speed with vacuum line disconnected and manifold opening covered) . . . . . . . . | 4° BTDC | 6° BTDC |

| Horns | Model | Type | Ampere Draw |
|---|---|---|---|
| | 9000475 | Standard | 8-11 Amps. 12.5V |
| | 9000476 | Optional | 8-11 Amps. 12.5V |

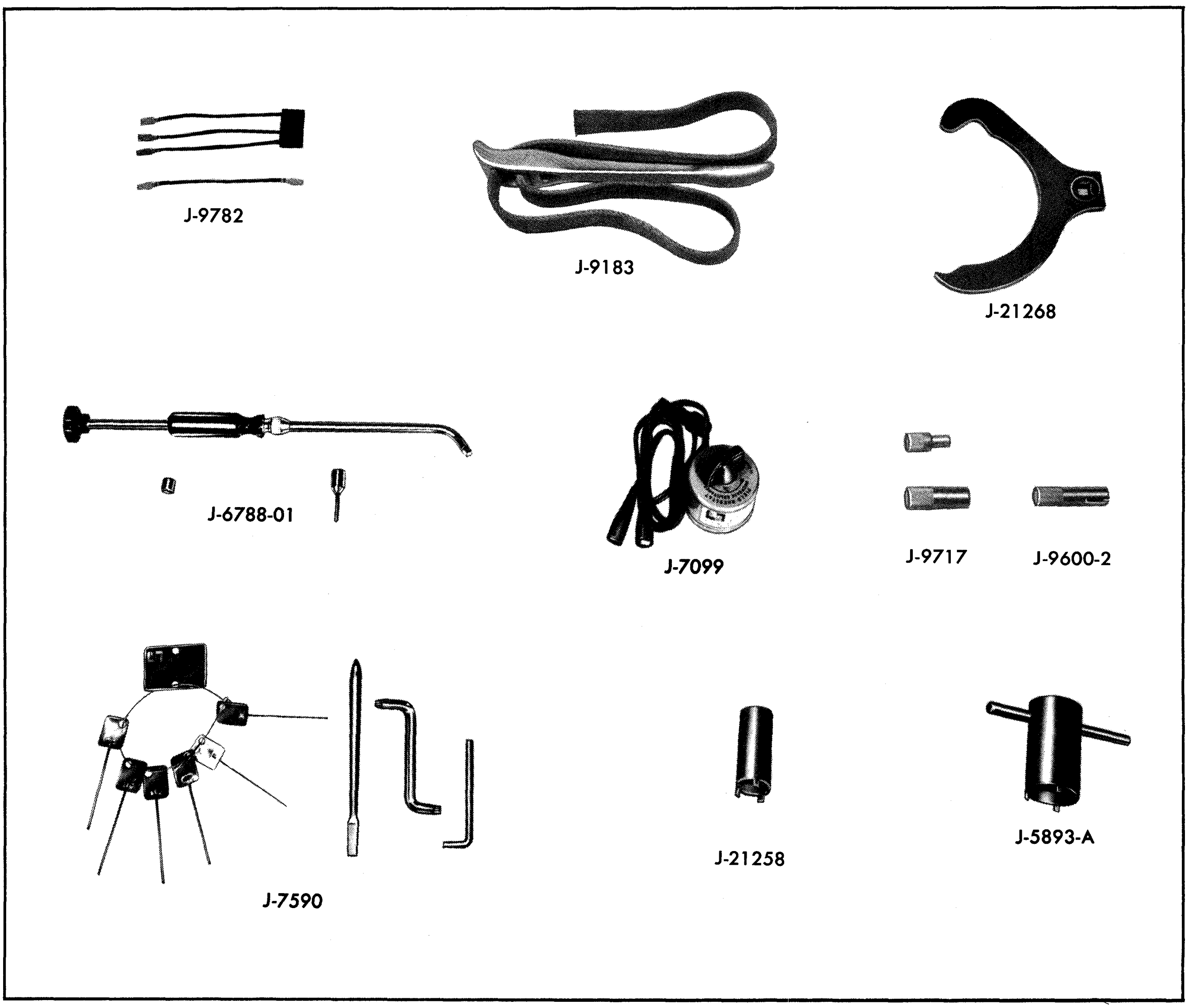
| Relays | Model | Application | Air Gap at Core —Points Closed (in.) | Point Opening (in.) | Closing Voltage (Range) |
|---|---|---|---|---|---|
| | 1115824 | Horn | .020 | .018 | 1.5-9.5 |

| FUSE DESCRIPTION | Fuse Type | Capacity (Amps.) | Option Standard |
|---|---|---|---|
| Air Cond. (Custom) Controls Lamp | AGC | 4 | O |
| Air Cond. (Custom) Power & Blower Motor | AGC | 20 | O |
| Ash Tray Lamps | AGC | 4 | O |
| Back-Up Lamps | AGC | 20 | O |
| Cigar Lighter | AGC | 20 | O |
| Cigar Lighter Lamp | -- | -- | - |
| Clock Lamps | AGC | 4 | O |
| Clock Power | AGC | 10 | O |
| Compass Lamp | -- | -- | - |
| Console Compartment Lamp | AGC | 10 | O |
| Console Courtesy Lamp | AGC | 10 | O |
| Directional Signals & Stop Lamp | AGC | 15 | S |
| Dome, Rear Quarter or Rear Courtesy Lamp | AGC | 10 | S |
| Electrocruise & Low Fuel Lamp | AGC | 20 | O |
| Heater Controls Lamp | AGC | 4 | S |
| Heater Blower Motor | AGA | 20 | S |
| Hydra-Matic Indicator Lamp | AGC | 4 | O |
| Ignition Switch Lamp | -- | -- | - |
| Instrument Lamps | AGC | 4 | S |
| Instrument Panel Compartment Lamp | AGC | 10 | O |
| Instrument Panel Courtesy Lamps | AGC | 10 | S |
| License Lamp | AGC | 10 | S |
| Lighting Switch Circuit Breaker | -- | 15 | S |
| Luggage Compartment & Utility Lamp | AGC | 10 | O |
| Parking Brake Warning Lamp | AGC | 20 | O |
| Power Antenna | AGC | 20 | O |
| Power Seat Circuit Breaker | -- | 40 | O |
| Power Tail Gate Window Circuit Breaker | -- | 40 | O |
| Power Windows (Side) Circuit Breaker | -- | 40 | O |
| Radio Dial Lamp | AGC | 4 | O |
| Radio Power | AGW | 2.5 | O |
| Rear Window Defogger | AGC | 20 | O |
| Spot Lamp | AGC | 20 | O |
| Tachometer | 1AG | 1 | O |
| Tail Lamps | AGC | 10 | S |
| Underhood or Underhood & Utility Lamp | AGC | 20 | O |
| Windshield Washer Pump | AGC | 20 | O |
| Windshield Wiper Motor | AGC | 20 | S |

## LAMP AND BULB CHART

| Lamp Description | Trade No. | Std. | Qty. |
|---|---|---|---|
| EXTERIOR LAMPS | | | |
| Back-Up* | 1156 | O | 2 |
| Head (Exp. & Dom.)* | Type 1 (SB) | S | 2 |
| Head (Left Rule of Road)* | Type 2X(SB) | S | 2 |
| Head (Right Rule of Road)* | Type 2 (SB) | S | 2 |
| License* | 1155 | S | 1 |
| Parking & Dir. Sig.* | 1157 | S | 2 |
| Spot (Field)* | 4404(SB) | O | 1 |
| Tail (22) | 93 | S | 2 |
| Tail, Stop & Sig. (22) | 1157 | S | 4 |
| Tail, Stop & Sig. (Exc. 22) | 1157 | S | 2 |
| INTERIOR LAMPS | | | |
| Ammeter (Tell-Tale) | 1895 | S | 1 |
| Ash Tray Illum. | 1445 | O | 1 |
| Auto. Trans. Ind. | 1895 | O | 1 |
| Cigar Ltr. Illum. | 1895 | O | 1 |
| Clock (Factory & Field) | 1895 | O | 2 |
| Console Courtesy | 89 | S | 1 |
| Courtesy (Instr. Panel) | 89 | O | 1 |
| Directional Sig. Ind. | 1895 | S | 1 |
| Dome Lamp* | 1004 | S | 1 |
| Headlamp Beam Ind. | 1895 | S | 1 |
| Heater Controls | 1895 | S | 1 |
| Instr. Panel Compt. | 1895 | O | 1 |
| Luggage Compt.* | 1003 | O | 1 |
| Oil Pressure (Tell-Tale) | 1895 | S | 1 |
| Parking Brake Warning | 1895 | O | 1 |
| Radio Dial | 1895 | O | 1 |
| Rear Seat Arm Rest (2267)* | 68 | S | 2 |
| Speedo. Illum. | 1895 | S | 4 |
| Tachometer | 1895 | O | 2 |
| Temp. Gage (Tell-Tale) | 1895 | S | 1 |
| Underhood* | 93 | O | 1 |

# SPECIAL TOOLS




| | | | |
|---|---|---|---|
| J-9782 | Regulator Connector Adapter | J-9717 | Diode Remover Tools |
| J-9183 | Alternator Strap Wrench | J-9600-2 | Diode Installer |
| J-21268 | Alternator Belt Tensioner | J-7590 | Alternator Regulator Service Set |
| J-6788-01 | Distributor Adjusting Tool | J-21258 | Instrument Panel Nut Wrench |
| J-7099 | 25 Ohm Rheostat | J-5893-A | Ignition Switch Ferrule Spanner |

Fig. 11-114 Special Tools

# HEATING AND ACCESSORIES

## CONTENTS OF THIS SECTION



# TEMPEST HEATER

## GENERAL DESCRIPTION

Pontiac's Tempest Heating and Defroster System provides rapid warm-up sensation and even distribution of warmed air to all parts of the car. All air entering the system is taken through hood high cowl vents providing air with a minimum of dust, foreign material and undesirable fumes.

The use of outside air exclusively provides constant and rapidly changing air inside the car, eliminating a smoke-filled interior and keeps the occupants comfortable.

The driver has fingertip temperature control of the air entering the car. When heated air is desired, the blower forces air taken from the hood high cowl air inlet duct through the heater core and then through an air distributing system to the air outlets.

The design of the heater and defroster system, its valves and controls permits a method of obtaining different amounts of forced air flow for ventilation.

### *AIR OUTLETS AND CONTROLS (Fig. 12-1)*

AIR OUTLETS

Heated air enters the interior of the car and is distributed by a center outlet grille opening at the bottom of the heater duct, which disperses air over the front floor area and is so aimed that it also directs air to the rear passenger compartment.

Additional outlets are provided on the right and left sides of the heater outlet air duct for additional air distribution to the driver and front seat passenger floor area.

CONTROL PANEL

The heater control panel (Fig. 12-2) is located to the right of the steering column. The panel has two levers sliding in a horizontal plane which control air flow and temperature. When these levers are in the extreme left position, all valves and control units are closed. The blower speed is controlled by a switch located to the left of the temperature and air levers.

FAN CONTROL

The fan control lever has four distinct positions - OFF, LO, MED, and HI; HI is in the full up position, LO and MED partially down, and OFF in the full down position (Fig. 12-3).

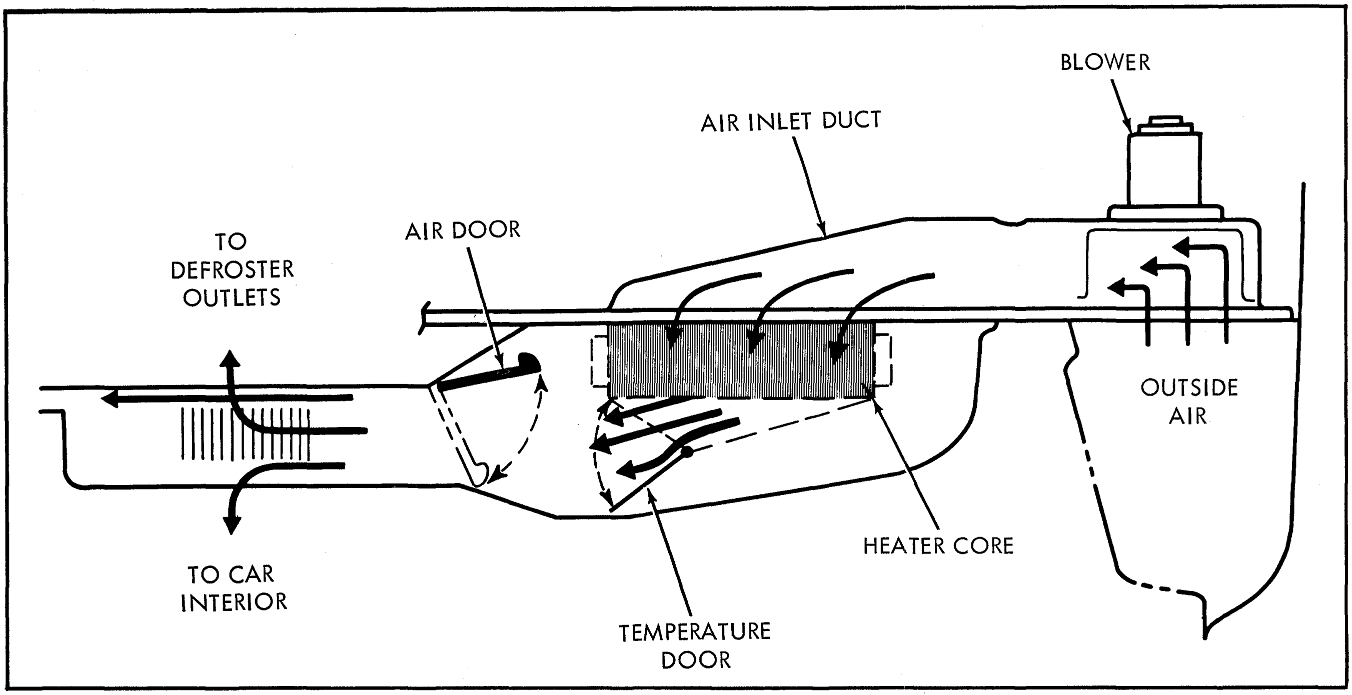



Fig. 12-1 Air Flow - Heater System

TEMPERATURE CONTROL

When the temperature control lever is in the extreme left position the heater air valve is closed preventing heat from entering the passenger compartment. As the lever is moved progressively to the right, more and more air is introduced through the heater core. In the full right position, maximum heat is obtained if the air control lever is positioned in NORMAL or DEFROST detent.

With the air control lever in the NORMAL detent, slide the temperature control to the full right position during engine warm up. After the inside of the car is at the desired temperature level, adjust the temperature lever to maintain this temperature.

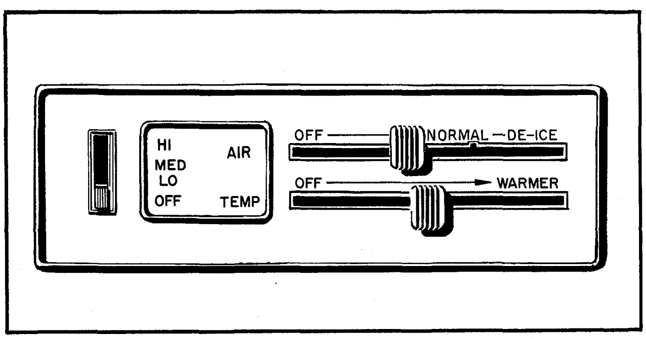



Fig. 12-2 Heater Control Panel

AIR CONTROL

With the air lever in the extreme left position very little air will enter through the heater system. As the lever is moved to NORMAL or DEFROST detent, outside air is introduced through the heater air system.

NORMAL detent position permits partial air flow out of the defroster nozzles while providing the majority of air flow through the heater air system.

Moving the air control lever to the right from the NORMAL detent position to the DEFROST detent position permits air to be directed to the windshield,

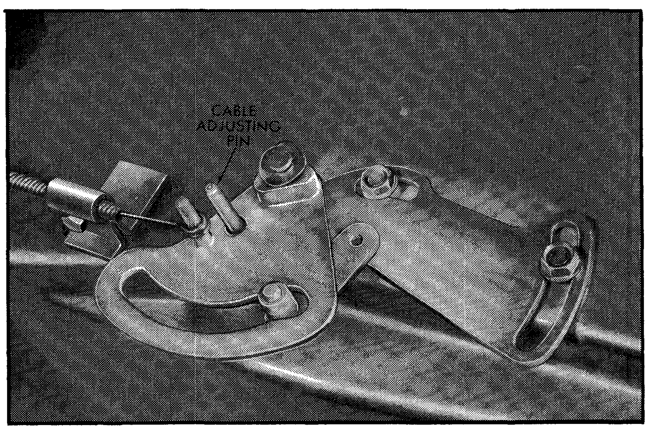



Fig. 12-3 Temperature Control Cable Adjusting Pin in Position

with only a limited amount of air coming out of the heater outlets.

## TIPS ON USE OF HEATER AND DEFROSTER SYSTEM

### *KEEPING COMFORTABLE IN EXTREMELY HUMID "MUGGY" WEATHER*

When the relative humidity is extremely high causing discomfort on a day when the temperature is 55°F.-70°F., move the air control lever to the mid-way position (normal) and move the temperature control lever to the right slightly. This will permit outside air to enter the heater core and provide minimum heating. Move the fan control lever to the low speed position.

### *KEEPING COMFORTABLE IN MILD WEATHER*

When the weather is cool, but the sun is very bright, as in spring or fall or at high altitudes, use both the heater and the cowl ventilators at the same time, positioning the air control lever at NORMAL detent and setting the temperature control and fan speed for desired comfort.

### *CONTROLLING TEMPERATURE IN CAR*

The most satisfactory method of controlling the temperature in the car is to:

1. Set air control lever to the right for maximum air flow (normal detent).

2. Position temperature control lever to the extreme right for maximum heating, then adjust to maintain the desired temperature in the car.

3. Set fan speed for your personal comfort.

### *USING THE HEATING SYSTEM FOR VENTILATION*

The heating system is designed so that it can also be used for ventilation when it is not necessary to warm the air. Ventilation may be obtained by placing the air control lever in the NORMAL detent position for maximum air flow and the temperature control lever in the extreme left (OFF) position to prevent the air from passing over the heater core. Select the amount of air flow desired by positioning the fan control lever at the speed desired.

## MINOR ADJUSTMENTS

### *TEMPERATURE CONTROL CABLE*

*NOTE: Some warming of air is normal even though temperature lever is at OFF. Cable should be connected securely at both ends before adjusting.*

1. Remove glove box.

2. Place temperature control lever in OFF position.

3. Adjust turnbuckle as necessary to allow 3/16" diameter gauge pin to pass freely from control cam into bracket on heater case (Fig. 12-3).

4. With gauge pin in place adjust turnbuckle to move control lever against end of slot in control panel, then turn in the opposite direction to move control lever 1/16 to 1/8 inch away from end of slot.

5. Remove gauge pin.

6. Move temperature lever to full heat then back to OFF and recheck to make sure gauge pin fits freely in index holes.

7. Replace glove box.

### *AIR CONTROL CABLE*

1. Place air control lever in OFF POSITION.

2. Hold outside air door lever on heater case in closed position.

3. Holding air door lever in off position, adjust turnbuckle to move control lever to full OFF position against end of slot in control panel, then turn in opposite direction to move control lever 1/16 to 1/8 inch from end of slot.

4. Operate lever to DE-ICE position, then back to OFF and check to see that there is a slight spring back from end of slot not to exceed 1/8".

### *DEFROSTER CONTROL CABLE*

1. Place air control lever in DE-ICE position.

2. Hold de-ice door lever in open (de-ice) position.

3. While holding door open, adjust turnbuckle to move control lever against end of slot in control panel, then turn in opposite direction to move control lever 1/16 to 1/8 inch from end of slot.

4. Operate control lever to OFF then back to DE-ICE and check to see that there is a slight spring back from end of slot not to exceed 1/8".

## MAJOR REPAIRS

### *HEATER CONTROL PANEL ASSEMBLY—REMOVE AND REPLACE (Fig. 12-4)*

1. Disconnect battery.

2. Remove radio.

3. Disconnect wires from blower control switch and control cables from heater core and case assembly.

4. Remove two stamped nuts at bottom and two at top from backside of heater control assembly.

5. Remove control assembly and remove cables.

6. Replace by reversing the above procedure.

7. Adjust air control bowden cable.

8. Adjust temperature control bowden cable.

9. Adjust defroster control bowden cable.

10. Connect battery.

### *HEATER FAN (BLOWER) SWITCH—REMOVE AND REPLACE*

1. Disconnect battery.

2. Remove radio.

3. Disconnect wires from blower switch.

4. Remove blower switch from control assembly.

5. Replace by reversing the above procedure.

### *TEMPERATURE CONTROL CABLE—REMOVE AND REPLACE*

1. Remove glove box.

2. Remove temperature control bowden cable from heater core and case assembly.

3. Remove temperature control bowden cable from control assembly.

4. Replace by reversing the above procedure.

5. Adjust the temperature control bowden cable.

6. Replace glove box.

### *AIR CONTROL CABLE—REMOVE AND REPLACE*

1. Remove radio.

2. Remove air control bowden cable from heater core and case assembly.

3. Remove air control bowden cable from control assembly.

4. Replace air control bowden cable.

5. Adjust air control bowden cable.

6. Replace radio.

### *DEFROSTER CONTROL CABLE—REMOVE AND REPLACE*

1. Remove radio.

2. Remove defroster control bowden cable from heater core and case assembly.

3. Remove defroster control bowden cable from control assembly.

4. Replace defroster control bowden cable.

5. Adjust defroster control bowden cable.

6. Replace radio.

### *BLOWER MOTOR OR AIR INLET DUCT ASSEMBLY—REMOVE AND REPLACE (Fig. 12-5)*

1. Hoist front end of car.

2. Remove right front wheel assembly.

3. Remove right front headlamp assembly.

HEAT CONTROL ADJUSTMENTS

NOTE: ALL ADJUSTMENTS TO BE MADE AFTER CABLES HAVE BEEN CONNECTED SECURELY AT BOTH ENDS:

TEMPERATURE CONTROL

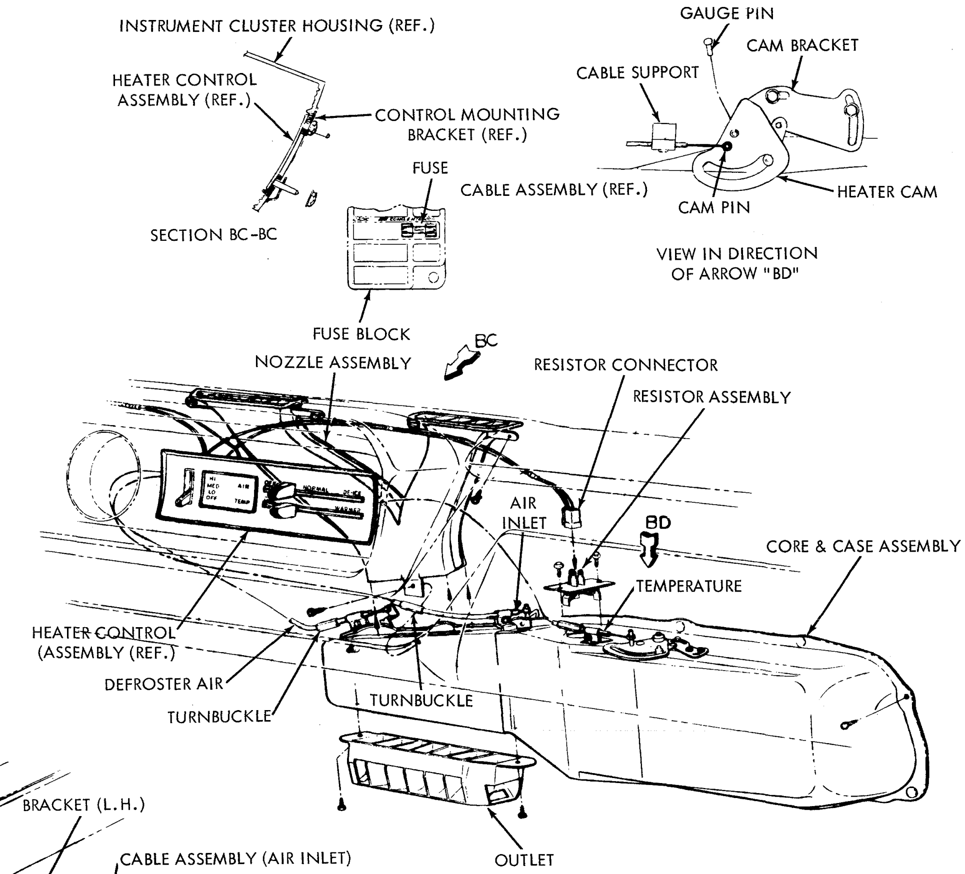
1. PLACE TEMPERATURE CONTROL LEVER (LOWER LEVER) IF FULL COLD OR OFF POSITION (EXTREME LEFT).
2. ADJUST TURNBUCKLE AS NECESSARY TO ALLOW 3/16" GAUGE PIN TO PASS FREELY THROUGH HEATER CAM AND CAM BRACKET INDEX HOLES.
3. WITH GAUGE PIN IN PLACE ADJUST TURNBUCKLE TO MOVE LEVER AGAINST LEFT END OF SLOT IN CONTROL PANEL, THEN TURN TURNBUCKLE IN OPPOSITE DIRECTION TO MOVE CONTROL LEVER 1/16" TO 1/8" AWAY FROM END OF SLOT.
4. REMOVE GAUGE PIN.
5. MOVE TEMPERATURE LEVER TO FULL HEAT OR WARMER POSITION, THEN BACK TO OFF.
6. GAUGE PIN MUST FIT FREELY THRU INDEX HOLES.

AIR CONTROL

1. PLACE AIR CONTROL LEVER (UPPER LEVER) IN OFF POSITION (EXTREME LEFT).
2. HOLD AIR DOOR CRANK ON HEATER CASE IN CLOSED POSITION (CRANK ROTATED FULL CLOCKWISE WHEN VIEWED FROM ABOVE).
3. WHILE HOLDING AIR DOOR IN CLOSED POSITION ADJUST TURNBUCKLE TO MOVE LEVER AGAINST LEFT END OF SLOT IN CONTROL PANEL, THEN TURN TURNBUCKLE IN OPPOSITE DIRECTION TO MOVE CONTROL LEVER 1/16" TO 1/8" AWAY FROM END OF SLOT.
4. MOVE LEVER TO DE-ICE POSITION THEN BACK TO OFF.
5. LEVER MUST HAVE SLIGHT SPRING BACK FROM END OF SLOT, NOT TO EXCEED 1/8".

DE-ICE

1. PLACE AIR CONTROL LEVER (UPPER LEVER) IN DE-ICE POSITION (EXTREME RIGHT).
2. HOLD DE-ICE DOOR IN DE-ICE OR FULL OPEN POSITION (CRANK ROTATED FULL CLOCKWISE WHEN VIEWED FROM THE REAR).
3. WHILE HOLDING DE-ICE DOOR IN DE-ICE POSITION ADJUST TURNBUCKLE TO MOVE LEVER AGAINST RIGHT END OF SLOT IN CONTROL PANEL, THEN TURN TURNBUCKLE IN OPPOSITE DIRECTION TO MOVE CONTROL LEVER 1/16" TO 1/8" AWAY FROM END OF SLOT.
4. MOVE LEVER TO OFF POSITION THEN BACK TO DE-ICE.
5. LEVER MUST HAVE SLIGHT SPRING BACK FROM END OF SLOT, NOT TO EXCEED 1/8".



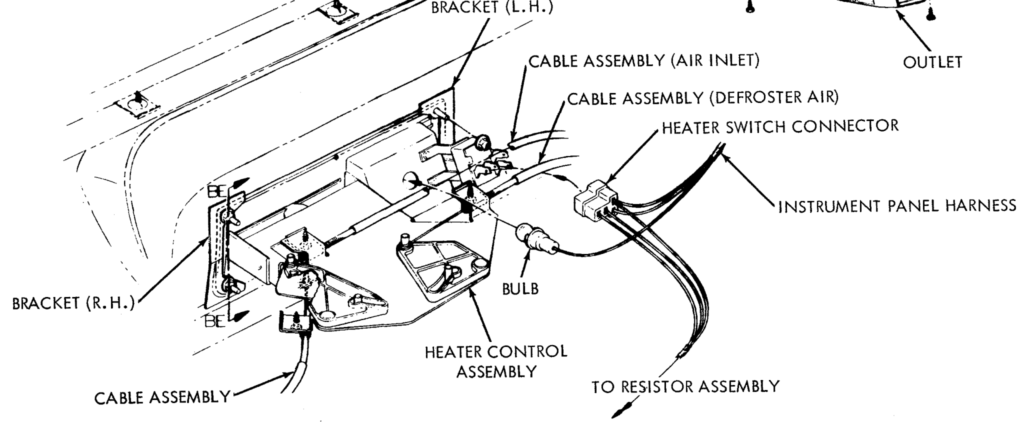



Fig. 12-4 Reference Illustration - Body Interior Details

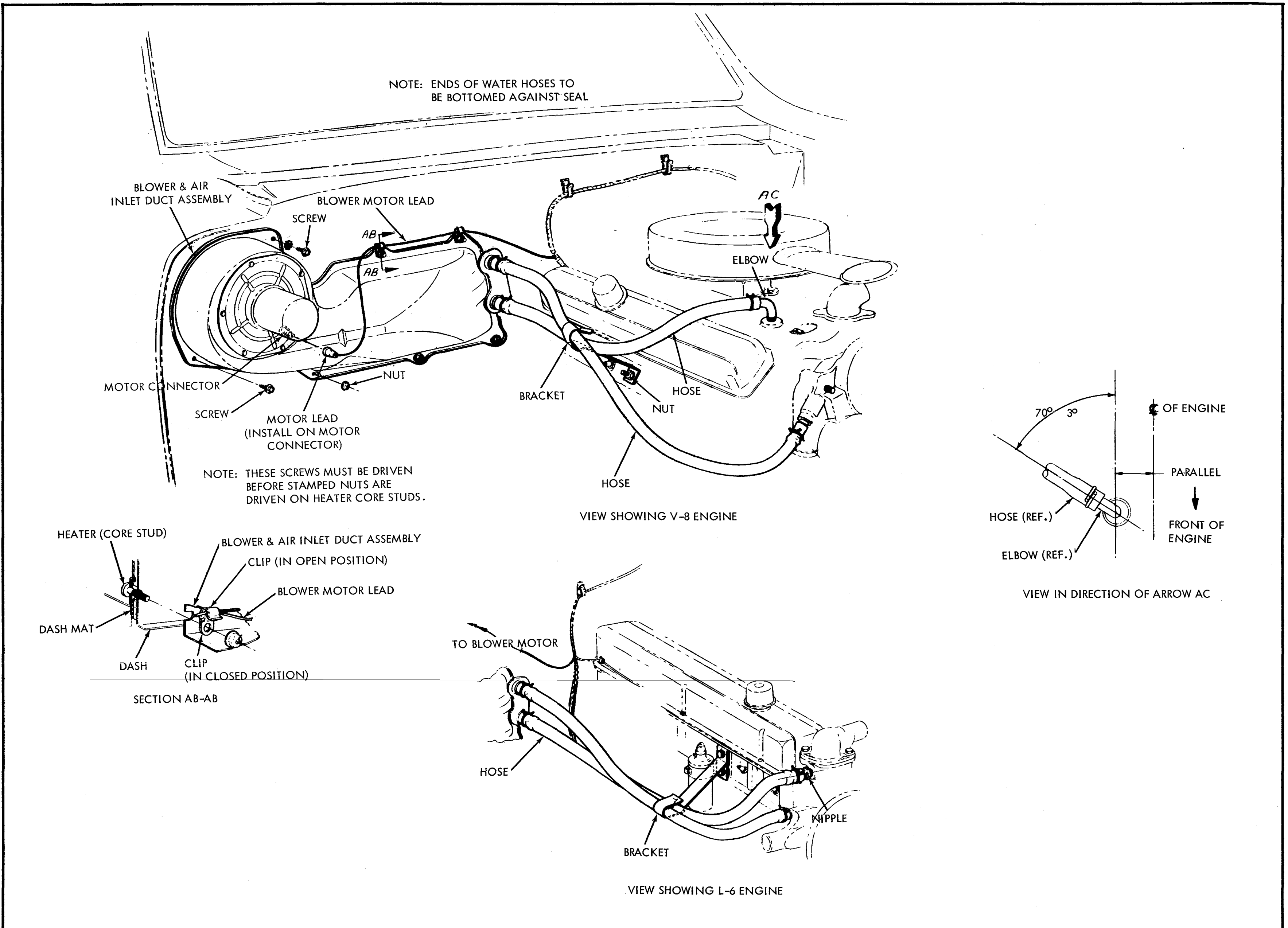



Fig. 12-5 Reference Illustration - Heater Parts in Engine Compartment

4. Remove right front fender assembly.

5. Disconnect wire at blower motor.

6. If blower motor only is to be replaced, remove five attaching screws and remove assembly.

7. If air inlet duct assembly is to be replaced, remove two attaching screws and five attaching nuts and remove assembly.

8. Replace by reversing the above procedure.

### HEAT CORE AND CASE—REMOVE AND REPLACE

1. Drain radiator and remove glove box.

2. Disconnect heater inlet and outlet water hoses at heater.

3. Disconnect control cables at heater core and case assembly.

4. Remove wire connector from resistor assembly at top left side of heater air outlet duct assembly by prying connector up with a flat blade screwdriver.

5. Remove six nuts securing heater to air inlet duct assembly and remove heater assembly.

6. Remove heater core and case assembly.

7. Replace by reversing above procedures.

8. Adjust control cables.

## OPERATING INSTRUCTIONS

To warm a car under various weather and driving conditions, use the following control settings after the engine has reached its normal operating temperature.

| CONTROL | SETTING |
|---|---|
| Fan control lever . . . . . | full up for high speed |
| Temperature control lever | extreme right, for maximum heating, then adjusted for occupant comfort |
| Air control lever . . . . . | extreme right until windshield is "de-iced" or "de-fogged", then to midway position for maximum air flow at heater outlets and partial defrost |
| Car windows . . . . . . . | front door vent and door window open slightly to assist in de-icing or de-fogging, then closed or positioned to provide comfort for all occupants |
| Side cowl ventilators . . . | closed |

### SLOW CITY DRIVING IN COLD WEATHER

| CONTROL | SETTING |
|---|---|
| Fan control lever . . . . | full up for high speed |
| Temperature control lever | extreme right for maximum heating, then adjusted for comfort |
| Air control lever . . . . | at midway position for maximum air flow and partial defrost |
| Car windows . . . . . . . | closed |
| Side cowl ventilators . . . | closed |

### NORMAL COOL WEATHER HIGHWAY CRUISING

| CONTROL | SETTING |
|---|---|
| Fan control lever . . . . | full up for high speed |
| Temperature control lever | position to obtain desired temperature |
| Air control lever . . . . | at midway position for maximum air flow and partial defrost |
| Car windows . . . . . . . | closed, door vent(s) may be opened to suit occupant comfort |
| Side cowl ventilators . . . | closed |

***COLD WEATHER HIGHWAY CRUISING***

| CONTROL | SETTING |
|---|---|
| Fan control lever . . . . | full up for high speed |
| Temperature control lever | extreme right for maximum heating, then adjusted for occupant comfort |
| Air control lever . . . . | at midway position for maximum air flow and partial defrost |
| Car windows . . . . . . . | closed |
| Side cowl ventilators . . . | closed |

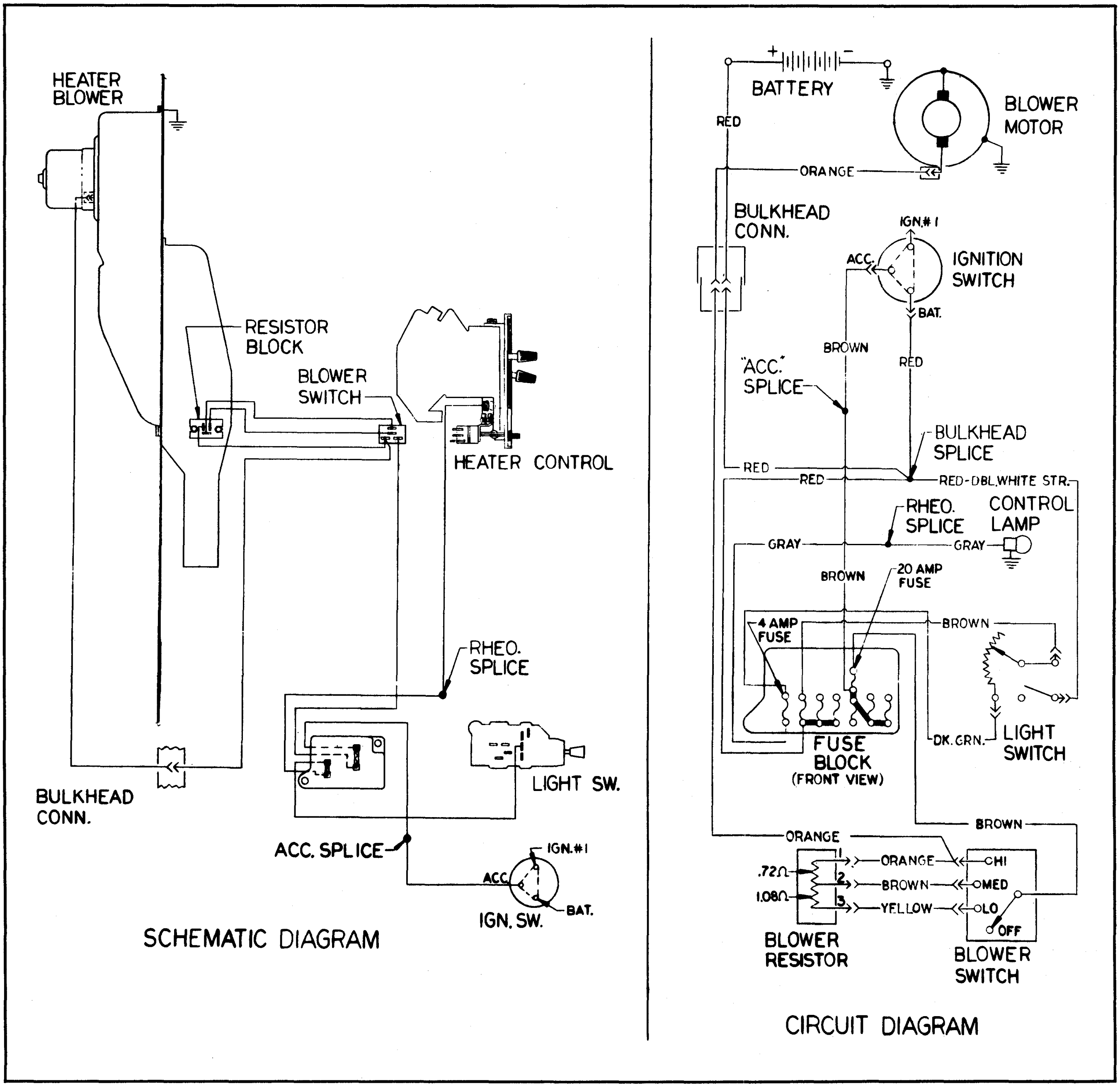



Fig. 12-6 Schematic and Circuit Diagram of Heater Electrical System

## TESTING

### *OPERATIONAL TEST*

The purpose of performing a heater operational test is to prove the heater system is operating properly.

PRELIMINARY CHECKS

Engine Compartment

1. Check radiator for proper engine coolant level.

2. Inspect radiator core and heater hoses for leaks, at the same time inspecting for kinked or collapsed heater hoses.

3. Inspect the blower to heater air distributor to see that it is properly installed (to prevent any air leaks from engine compartment, which may have objectionable fumes or odors).

Inside Car Body

1. Check to see that control levers operate smoothly, and they are in alignment when all are in the off position.

2. Start engine.

3. Place "FAN" control lever in OFF position; blower should not operate.

4. Move "FAN" lever to the LO and MED position; blower should operate. Continue by moving lever to the HI position; blower should operate at a speed faster than at LO and MED positions.

5. Move AIR lever slowly to the right until the normal detent is reached (slightly to right of center); more and more air should flow through outlet as lever is moved.

6. Move "AIR" lever slowly until the extreme right position is reached, at the same time sensing the amount of air flowing from the defroster outlets. More and more air should flow through these outlets as the lever is moved to the right.

7. After engine has warmed up, move "TEMP" control lever from the extreme left to the extreme right position. Air at outlet should get progressively warmer.

Should the heater control levers operate satisfactorily during the above checks, it would appear that heater controls operation is normal. If during the checks irregularities are noted or complaints on heater operation could not be noted or determined, then refer to TROUBLE DIAGNOSIS for the complaint or cause and the remedy.

## HEATER TROUBLE DIAGNOSIS

### *INSUFFICIENT HEATING*

| COMPLAINT OR CAUSE | REMEDY |
|---|---|
| Slow warming in car. | Incorrect operation of controls. Advise operator of proper operation of heater controls. |
| Objectionable engine or exhaust fumes in car. | Check for good seal between hood and cowl. Check for good seal between vent grille and cowl. Locate and seal any other air leaks. |
| Cold drafts on floor. | Check operation and adjustment of cowl vent cables. Check adjustment of air valve cable. Advise operator of proper operation of heater system. |
| Insufficient heat to rear seat. | Check for obstructions under front seat. Advise owners to operate blower. |
| Low engine coolant level. | Check radiator and fill to proper level, run engine to clear air lock. |

### *INSUFFICIENT HEATING (Continued)*

| COMPLAINT OR CAUSE | REMEDY |
|---|---|
| Failure of engine cooling system to warm up. | Check radiator cap and engine thermostat and replace if required. See section on ENGINE COOLING AND LUBRICATION. |
| Kinked heater hoses. | Remove kink or replace hose. |
| Foreign material obstructing water flow in heater core. | Remove foreign material if possible, otherwise replace core. |
| Temperature control cable improperly adjusted. | Adjust cable. |
| Air valve does not open. | Check for proper installation and/or adjustment of air control cables. |

### *INADEQUATE REMOVAL OF FOG OR ICE*

| CAUSE | REMEDY |
|---|---|
| Air door does not open. | Check for proper installation and/or adjustment of air control cable. |
| Temperature control door does not open. | Check and adjust temperature control cable. |
| Defroster door does not open fully. | Adjust air control cable. |
| Obstructions in defroster outlets at windshield. | Remove obstruction. |
| Blower motor not connected. | Connect wire. |
| Inoperative blower motor. | Check heater fuse.<br>Replace motor. |
| Inoperative blower motor switch. | Replace switch. |

### *TOO WARM IN CAR*

| CAUSE | REMEDY |
|---|---|
| Inoperative temperature control door. | Adjust temperature control cable. |
| Incorrect operation of controls. | Advise operator of proper operation of heater system. |

### *BLOWER INOPERATIVE*

| CAUSE | REMEDY |
|---|---|
| Blown fuse. | Replace fuse. |
| Inoperative motor. | Replace motor. |
| Open circuit. | Replace circuit between ignition switch, blower switch, and blower motor. |
| Inoperative blower motor switch. | Replace faulty switch. |

### *MISCELLANEOUS*

| PROBLEM | REMEDY |
|---|---|
| Control levers not aligned due to incorrect adjustment. | Adjust control cables. |
| Blown fuses. | Shorts in electrical system.<br>Locate and correct short.<br>Blower wheel rubbing on case.<br>Failed blower motor. |
| Heater "gurgle". | Check engine coolant level in radiator. |

## SPECIFICATIONS

**Cooling System Capacity (Engine with Heater)** . . . . . . . . . . . . . . . . . . . . . . . . L-6, 11.3 qts. V-8, 20.5 qts.

**Fuse Sizes**

Heater Electrical System (on fuse block - special 5/8" fuse) . . . . . . . . . . . . . . . . . . . . 20 amp.

Heater Control Panel Lamp (on fuse block) . . . . . . . . . . . . . . . . . . . . . . . . . . . 4 amp.

## PUSH BUTTON RADIO

### *DESCRIPTION*

The all-transistorized Push Button Radio (Fig. 12-7) gives instant response when radio is turned on. Station pick-up and power output are excellent and current drain is less than half that of manual types.

The radio is designed to allow manual or push button tuning and has additional advantages of automatic volume control and excellent tone control.

### *ON CAR TROUBLE DIAGNOSIS*

Most radio complaints usually fall into one of three categories; the radio is either dead, weak or noisy. Before removing a radio from the car, a few simple checks can be made in a very short time. In some cases the radio will not need to be removed at all. Refer to the RADIO TROUBLE DIAGNOSIS before removing radio.

If all the diagnosis checks fail to turn up the problem, the condition is in the radio itself. The radio should be removed from the car and sent to an authorized service station. Enclose all pertinent information, including date of purchase, mileage, customer's name and address and customer's complaint. This information is important to the radio technician and will aid him when making repairs.

### *RADIO—REMOVE AND REPLACE (Fig. 12-8 and 12-9)*

1. Remove radio control knobs.

2. Remove retaining nuts and escutcheons.

3. Disconnect antenna and speaker leads.

4. Remove lamp wire assembly (top of receiver on push button models—bottom of receiver on manual radios).

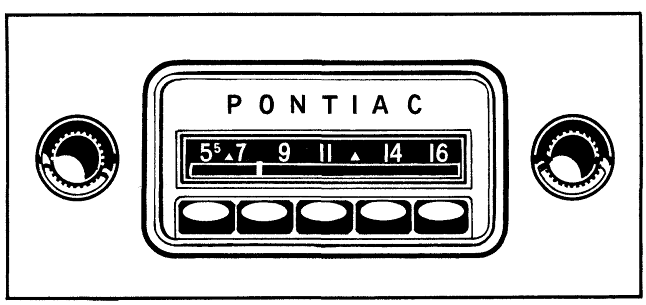



Fig. 12-7 Tempest Radio

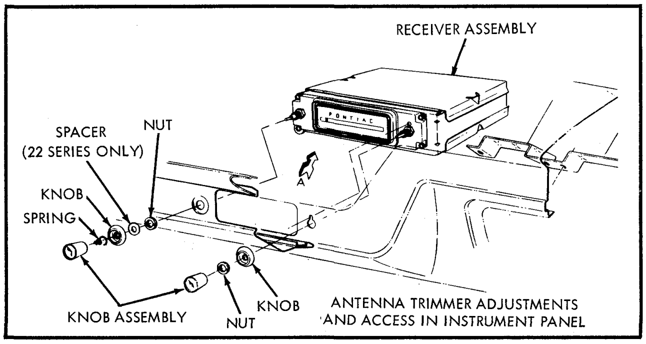



Fig. 12-8 Tempest Radio - Front View - Reference Illustration

5. Remove support to radio bracket bolt and washers and remove radio.

*NOTE: On Custom air conditioned cars it will be necessary to remove the cold air distributor duct.*

### SPEAKER—REMOVE AND REPLACE (Fig. 12-10)

1. Remove speaker and support assembly.

2. Remove screws and nuts securing speaker to speaker support.

3. Disconnect output connector and remove speaker.

4. Reverse above procedure to install.

### ADJUST ANTENNA TRIMMER

In order to make the antenna trimmer adjustment, the car should be outdoors and as far removed from

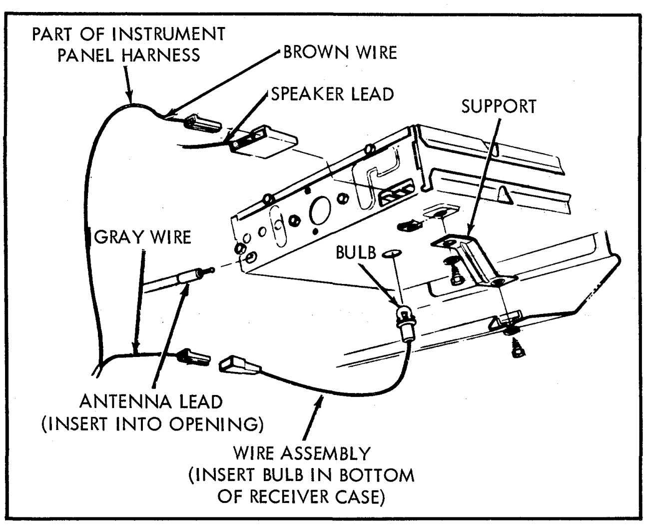



Fig. 12-9 Tempest Radio - Rear View - Reference Illustration

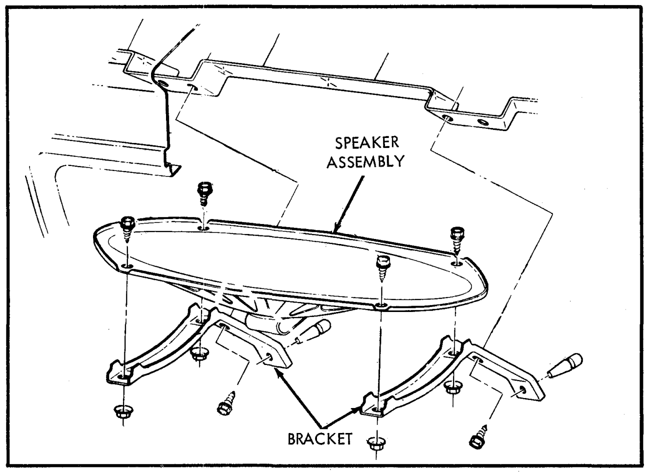



Fig. 12-10 Front Speaker Installation

electrical disturbances as possible. Set the manual antenna to its minimum height and the electric antenna height at 28 inches. Tune in a weak station between 600 and 1000 kilocycles and turn the volume control on full. This is necessary in order to offset the action of the automatic volume control. Using a screwdriver, turn the trimmer adjusting screw located behind the dummy knob on the manual tuning shaft. Turn the screw until the station peaks in volume.

The antenna trimmer adjustment should be made after a set has been removed from the car and worked on by a radio repair man. The reason for trimming the antenna after service work has been performed is that the radio repair man will undoubtedly have adjusted the trimmer to match his antenna so that it no longer matches the antenna in the car from which it was removed.

Trimming the antenna is especially important with the all-transistor radios as this will directly offset sensitivity and selectivity. Complaints of station "mixing" on all-transistor radios can be reduced by this adjustment.

### SET RADIO PUSH BUTTONS

1. Turn radio on.

2. Select five desired stations (set buttons one at a time).

3. Pull selector button out as far as it will go.

4. Tune in the desired station, using the manual control knob.

5. Push the selector button in and release.

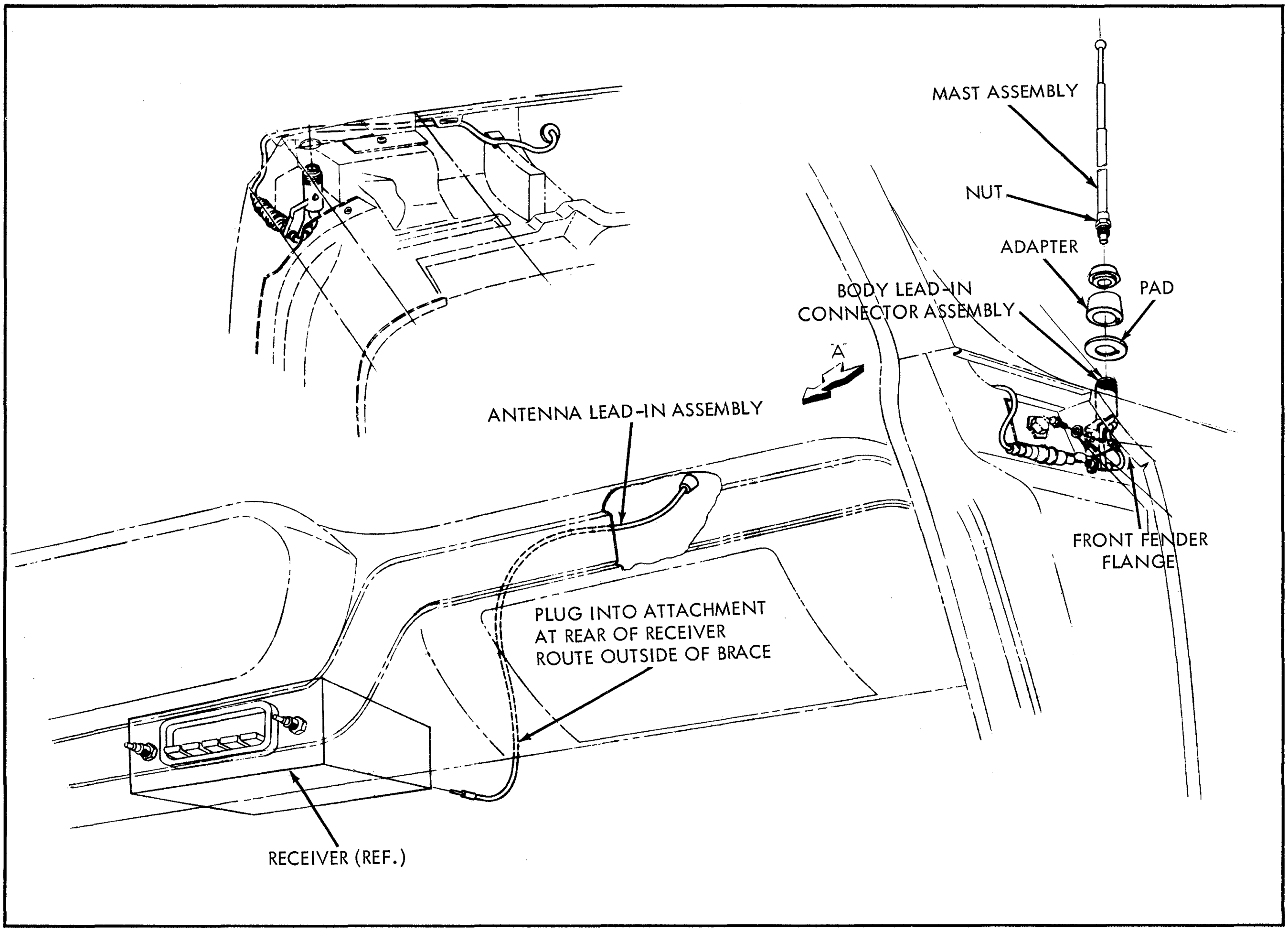



Fig. 12-11 Reference Illustration - Tempest Antenna

## MANUAL ANTENNA

The manual antenna is mounted on the right front fender, in approximately a vertical position (Fig. 12-11).

### *PERIODIC SERVICE*

Many antenna troubles can be prevented by cleaning the antenna mast at periodic intervals (at least once a month). This is easily performed by wiping the extended mast with a soft cloth when the car is being lubricated or washed.

During the winter months the mast should be lubricated also by wiping it with a cloth containing a light oil.

### *ANTENNA BODY—REMOVE AND REPLACE*

1. Open right front door.
2. Disconnect antenna lead in from antenna body.
3. Remove screw from antenna mounting bracket.
4. Remove antenna mast.
5. Remove nut, adapter and pad from antenna body.
6. Replace by reversing the above procedure.

### *ANTENNA LEAD-IN—REMOVE AND REPLACE*

1. Remove glove box.
2. Disconnect lead-in plug from radio receiver (Fig. 12-11).
3. Remove windshield wiper arm.
4. Remove air intake grille.

5. Disconnect the antenna lead-in from antenna body and remove antenna lead-in from vehicle.

6. Replace by reversing the above procedure.

## REAR SEAT SPEAKER

### DESCRIPTION

The radio rear seat speaker system employs a single speaker and is controlled by a lever mounted under the instrument cluster bezel. The speaker is mounted below the package shelf.

Control of the speaker features a circuit design whereby switching a choke coil and condenser in and out of the circuit causes the lower frequency tone to be accentuated in the rear and the high frequency tone in the front.

Operation of the control for ideal sound selection is as follows:

1. Front speaker - full response.

2. Front and rear - Sera-Phonic sound.

3. Rear speaker - full response.

## RADIO TROUBLE DIAGNOSIS

### ALTERNATOR NOISE

Connect capacitor from the "BAT" terminal on the alternator to ground or frame of the car.

### VOLTAGE REGULATOR NOISE

Place capacitor between the "V" terminal of the regulator and chassis.

### BALL ON END OF ANTENNA ROD

Ball eliminates the sharp point and reduces the effect of static discharge. Curb feelers bent too close to ground will cause noise in the auto radio.

### WHEEL STATIC

Caused by voltage being developed as the wheel rotates on the axle. Noise is eliminated by placing wheel static collectors in the two front wheels; button end of spiral spring must ride snugly in hole on end of axle and be free from grease.

### TIRE STATIC

Caused by electrical charge being built up inside tire due to friction between tire and road. Noise is eliminated by inserting tire static powder into tires using a special injection gun.

CAUTION: *Inject powder carefully or powder will backfire in face.*

### MOST AUTO RADIO COMPLAINTS FALL INTO ONE OF THREE CATAGORIES

#### A. Radio Is Dead

1. Thump check radio—turn radio on and listen intently for a distinct "thump" from the speaker which should be heard as current builds up through the power transistor.

a. If "thump" is heard, go to check (3).

b. If no "thump", check fuse.

(1) A 2.5 ampere fuse is used in all Pontiac radios. If radio plays, after replacing fuse, tap radio with rubber mallet or heel of hand and race the engine; if another fuse blows, remove radio for repair.

(2) If fuse is OK, check all radio interconnecting cables for secure connections. If still no thump, remove radio for repair.

(3) Check antenna by substitution; simply unplug regular antenna and plug in a spare. If radio is still dead, remove for repair.

#### B. Radio Is Weak

1. Check to see if antenna trimmer is peaked by tuning to a weak station and grasping antenna rod with hand. If volume drops considerably the trimmer is peaked properly; if the volume remains same or increases slightly, antenna trimmer needs adjusting. Use procedure outlined under ADJUST ANTENNA TRIMMER.

2. If radio is still weak, trimmer does not peak, check antenna by substitution.

3. Plug speaker in securely. Make sure speaker is plugged in securely at radio. If radio is still weak, remove the receiver for repair.

**C. Radio Is Noisy**

1. Constant noise complaint is almost always due to a defect inside the radio but could be caused by a bad antenna. Check with a substitute antenna.

2. Noise when tapped or jarred, is caused by loose antenna connection to the radio, a poor connection to car's power, poor speaker connection, or a loose part or connection inside the radio.

3. Noisy only when engine is running due to faulty noise suppression equipment.

   a. Check antenna lead-in shielding for proper grounding at both antenna base and radio. Poor connections at either of these points can result in engine noise interference.

4. If noise is present only while car is moving, problem is either wheel or tire static, or the result of missing ball at antenna tip.

   a. To check for wheel or tire static, drive car on a macadam road until noise is noticed then apply brakes; if noise disappears, it's wheel static; if noise persists, it's tire static.

5. Noisy when car equipment is operated such as directional lights, brake lights, power seat, or power windows.

   a. Check to see that lead-in wire is tight and properly seated in radio.

   b. Make certain antenna body is grounded to car body.

If all the above checks fail to turn up the problem, the condition is in the radio itself. The radio should be removed from the car and sent to an authorized service station. Include all pertinent information that might help the radio technician repair the radio as quickly as possible.

## ELECTRIC CLOCK

The electric clock operates on direct current from the car battery and must not be compared too closely for accuracy to the home electric clock operating on alternating current. The cycles per second of alternating current used in the home are controlled and periodically corrected at the power house, thereby eliminating accumulation of errors.

With the direct current system no such control is possible; therefore, automobile electric clocks will accumulate errors day by day the same as hand wound, spring operated clocks.

The electric clock provides automatic regulation of the rate when the position of the hands is changed manually. Moving the hands forward or backward adjusts the length of the hair spring to make the clock run faster or slower. The amount of change in rate depends upon the amount the hands are changed. Maximum rate change is approximately 20 seconds per day and is obtained when the hands are moved five minutes. If the clock is reset less than five minutes the change in rate is proportionally less than 20 seconds.

### *SETTING CLOCK*

When setting clock to correct for errors in time, pull reset stem out, move hands counterclockwise to correct time if clock is running fast, or move hands clockwise to correct time if clock is running slow, then allow reset stem to return to its normal position. This will automatically adjust the rate of the clock.

Owners should be advised to set the clock to the correct time once a week at regular intervals to ensure maximum accuracy.

### *CLOCK—REMOVE AND REPLACE*

1. Disconnect power lead and remove lamps at rear of clock.

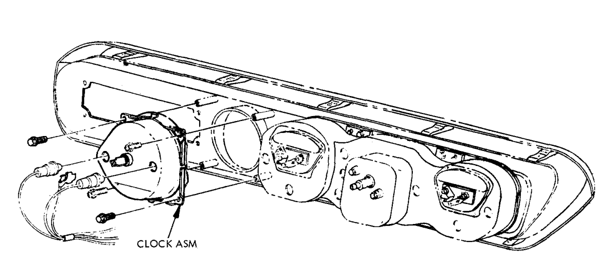



Fig. 12-12 Reference Illustration - Tempest Clock

2. Remove four retaining screws (Fig. 12-12).

3. Remove clock from back of instrument panel.

4. Replace by reversing above procedures.

*NOTE: On custom air conditioned cars it will be necessary to remove the cold air distributor duct.*

## BACK-UP LAMPS

The back-up lamp switch on automatic transmission equipped cars is incorporated in the starter neutralizer switch. This switch is located on the steering column on column shift automatics and in the console on floor shift automatics.

The back-up lamp switch used with vehicles equipped with column shift synchromesh transmissions is mounted on the steering column. Moving the shift lever to the reverse position causes the switch actuating pin in the gearshift lower lever to close the switch, completing the electrical circuit anytime the ignition key is in the ON or ACC position.

The actuating pin should be adjusted to clear the switch by 1/8" when the gearshift lower lever is moved into second gear position.

## TACHOMETER

### DESCRIPTION

The tachometer is mounted in the right opening of the cluster and bezel assembly, utilizing the same opening usually reserved for electric clock.

This unit indicates the number of engine rpm in hundreds and has an adjustable red pointer which can be moved to any desired position on the dial to indicate pre-determined shift points.

### TACHOMETER—REMOVE AND REPLACE

1. Disconnect power lead and remove lamps at rear of tachometer.

2. Remove four retaining screws.

3. Remove tachometer from back of instrument panel.

4. Replace by reversing above procedures.

*NOTE: On custom air conditioned cars it will be necessary to remove the cold air distributor duct.*

### RESET TACHOMETER NEEDLE

If it becomes necessary to reset the tachometer, a precision tachometer must be hooked up to work in conjunction with assembly in car.

1. Remove cluster and bezel assembly as outlined above, but do not disconnect leads.

2. Connect precision tachometer to assembly in car.

3. Remove round metal plug from rear of tachometer housing.

4. Turn engine over at 3000 rpm as indicated on precision tach (lower or higher readings may result in inaccurate needle setting).

5. Insert small screwdriver through hole at rear of housing and turn rheostat clockwise to lower needle or counterclockwise to raise needle.

6. When proper needle setting has been obtained as indicated on precision instrument, turn engine off, remove precision tachometer and replace unit by reversing removal procedures.

# INDEX

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